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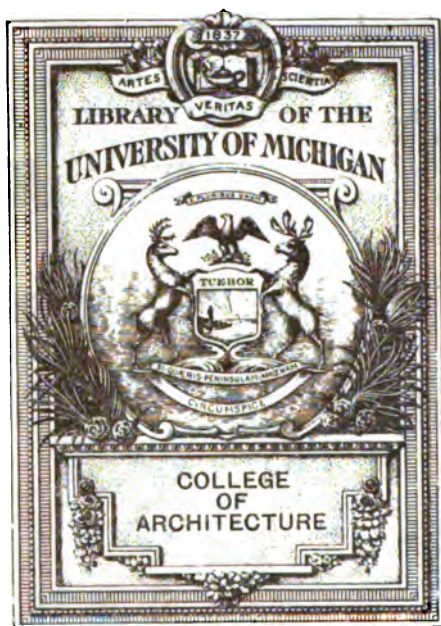
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UNITED STATES BUREAU OF EDUCATION  
BULLETIN, 1910, NO. 5 - - - - - WHOLE NUMBER 444

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# AMERICAN SCHOOLHOUSES

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PROFESSOR OF PHILOSOPHY AND EDUCATION  
IN THE UNIVERSITY OF ALABAMA



WASHINGTON  
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## LETTER OF TRANSMITTAL.

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DEPARTMENT OF THE INTERIOR,  
BUREAU OF EDUCATION,  
*Washington, December 23, 1910.*

SIR: It has been estimated that this country spends approximately seventy millions of dollars annually in the erection of public-school buildings. This estimate does not include buildings for normal schools, colleges, and universities. There can be no doubt that a substantial portion of this sum might be saved and improvement made at the same time in the adaptation of these buildings to sanitary and educational purposes, as well as in their architectural appearance, by a more general diffusion of knowledge respecting the recognized standards of schoolhouse construction. The monograph presented herewith for publication is intended to promote such saving and improvement, and thereby to "aid the people of the United States in the establishment and maintenance of efficient school systems and otherwise promote the cause of education throughout the country," as provided in the act for the establishment of this office.

The need of such a publication is increased by changes in school organization and instruction in recent years, which are reflected in the types of schoolhouse now generally approved by competent schoolmen and architects. It is a need which has been impressed upon the staff of this office by repeated inquiries from all parts of the country for information such as is here presented. These inquiries have come with especial urgency from the South and West, where the establishment of new high schools has been going forward with great rapidity. For the most part the principles which apply to the erection of high-school buildings apply equally to the erection of buildings for elementary schools. It has been possible, accordingly, to give to this publication a general character, and I believe it will be found useful in connection with schoolhouse construction for public schools of every grade and in all parts of the country. Wherever a limitation must be made, however, the schools which the author has had particularly in mind have been the high schools in small cities and towns of the South and West.

Prof. Dresslar has been able to draw upon an extended experience in the States of Indiana, California, and Alabama. Within recent years he has been consulted by many boards of education in the two States last named with reference to plans for new school buildings. He approaches the subject from the twofold point of view of a practical schoolman who is also a trained specialist in the field of school hygiene. The considerations upon which he lays especial emphasis are, accordingly, of the utmost importance as regards the plans of buildings for school use.

In the belief that such a publication will be one of the most useful that the Bureau of Education could put forth at this time, it is accordingly recommended that this monograph be issued as one of the numbers of the Bulletin of this office.

Very respectfully,

ELMER ELLSWORTH BROWN,  
*Commissioner.*

THE SECRETARY OF THE INTERIOR.

## FOREWORD.

In preparing this bulletin the writer has addressed himself to some of the more important questions with which school boards and architects have to deal when they enter upon the work of planning a school building. It is not a treatise on school hygiene, but a discussion of the requirements of school buildings from the schoolman's point of view and includes numerous illustrations of modern school buildings.

Through the aid of the United States Commissioner of Education, and the superintendents of public instruction of many of the States, I have had the opportunity to study the floor plans and elevations of a very large number of modern school buildings. The examples which are here reproduced represent what seem to me to be types of the best school buildings in our country. In making the selections I have had in mind the needs of both city and country, but somewhat more especially the needs of those who are planning to erect buildings for small to medium sized high schools. I am under lasting obligations to those architects and school officers who have so kindly assisted by furnishing plans and photographs. It has not been possible to reproduce all that have been offered, both on account of the number and on account of the great labor of making tracings from the blue prints to meet the demands of the printer. Many deserving plans and elevations put at my disposal must therefore of necessity be left out, but I indulge the hope that those which are reproduced will give a fair representation of the trend of present-day school architecture in our country, and at the same time furnish suggestions to school boards and architects interested in schoolhouse construction. There is, I am sure, a wealth of suggestion and counsel to all those who are willing to make a careful study of the floor plans, basements, conveniences, and elevations here presented. Furthermore, to those who are mainly interested in the schools as social institutions, I commend a study of these plans both as a record of progress and as a forecast of better things yet to come.





# AMERICAN SCHOOLHOUSES.

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## LOCATION OF A SCHOOLHOUSE.

The first thing to consider in selecting a site for a school building is, of course, the convenience of all the children. The schoolhouse ought to be so situated as to make it most easily accessible for the greatest number. But the fear of some possible inconvenience in this way to a part of the pupils should never allow more important considerations to be neglected. It is a matter of small moment that a few of the children be compelled to walk a little farther than the others, if thereby a better and larger school ground can be secured. It seems to be a very difficult matter to get parents to fully realize how important to the comfort, pleasure, and welfare of the children are large and well situated school grounds. They can readily see that cattle and horses will not thrive and remain healthy when kept in small inclosures, but for some reason they do not extend the same consideration to their children. Hundreds of towns and villages and even many large cities could have large school grounds well located, instead of cramped quarters in the midst of noise and dust, if the people could be persuaded that the hardship imposed on children in walking a longer distance to school is far less serious than that of being housed in buildings situated on small lots, hemmed in by other buildings, and immersed in foul air, much dust, and the din of the hurrying multitudes. There is a show of reason in providing buildings near their homes for children in the primary classes; but those in the intermediate grades and the high school would be accommodated better and more rationally from every point of view, even at the expense of a long walk, if, upon arrival at the schoolhouse, they could have before them a day's work in a pure atmosphere and free from the interruptions of outside life.

While the location of the schoolhouse is primarily and necessarily the duty of a school board or of some special officer to whom this duty is delegated, it is nevertheless true that teachers, if prepared to advise in such matters, can often be of the greatest assistance by bringing before the minds of the people the important questions of hygiene.

The lack of such professional interest was forcibly illustrated to me some years ago. I was engaged to teach in the high school of a

thriving town where the people were hearty supporters of their public schools, and invariably evinced their interest by electing their most intelligent townsmen to positions on the school board. At the time in question three college men had been chosen, all of whom were leading physicians. During the year previous, the same board had erected an additional building. A lot was chosen in the worst possible place. There happened to be for sale at the time a rather large block of ground in, topographically, the lowest part of town. It was a worthless piece of ground and had been shunned even by manufacturing establishments because it was too low and wet. Just to the east there was a livery stable, while to the west one block away there was a flouring mill and a railway with noisy, smoky engines frequently tugging their trains up a heavy grade. To the south, running along the edge of the grounds, there was a little stream which of necessity carried away much of the surface water from the public streets. The bed of this stream was scarcely 6 feet lower than the foundation of the building. Here, despite these and many other unfavorable conditions, a large brick building had been erected and into it hundreds of the children of the town were gathered. Think of what this means! Forcing all the children of a town who attend a high school to spend the best hours of the best part of their lives in a place not fit for even a factory is not only a crime against the children but it is in direct opposition to the spirit, if not the letter, of the law. Much time is wasted in that school every day, for the teachers must often stop the recitations until the noisy trains have gone by. There is not the least doubt in my mind that if the teachers had been alive to the questions of school sanitation even in this one regard, they could have been instrumental in averting this serious blunder. The average business man does not think of these things, and it is the duty of the teachers to bring the facts clearly before the people.

In the location of all structures for the habitation of man, the selection of the soil upon which the building is to stand is an important consideration. This is especially true with schoolhouses, for it must be remembered that every sanitary precaution necessary in private homes should be enforced many times more rigorously in schoolhouses. All authorities agree that such buildings should be located on soil as free from moisture as possible. Because of the importance of this requirement it will be well to consider the reasons at some length.

In the first place, it is necessary to know that the interstices of the soil are filled with air, and that this air is in motion just in the same way as the air above ground, though of course to a much less degree. Cold air is heavier than warm air and will displace it, even if the latter is under ground. The air which is thus forced up from

below the surface is impure. Its composition has been changed because of its contact with the soil. The decomposition of the organic matter contained in the soil, through the agency of bacteria, "those most universal of all scavengers," greatly decreases the amount of oxygen, while at the same time it generates a large amount of carbon dioxid. Hence it happens that air coming from the ground contains a much greater percentage of carbon dioxid and other noxious gases than the ordinary surface air. The greater the amount of decaying matter there is in the soil, the greater will be the pollution of the ground air. When the soil is pervious the air moves through it more freely than when it is close and heavy, and in this way it is much more quickly purified. When a pervious soil becomes dry, decomposition of the organic matter within it is very much retarded; for it is only in the presence of warmth and moisture that this organic matter is broken up. A soil, therefore, which is always kept moist by the ground water rising too near the surface will be continually throwing into the outside air more impurities than a dry soil. An impervious soil, in which the air and water both move more sluggishly, will pollute the air to a greater degree, other things equal, than a pervious soil, and is therefore a more dangerous spot upon which to build a house.

The soil beneath a building is usually dryer than it is around it. Hence, especially in rainy weather, there is a tendency for the ground air to move from all sides toward the more porous soil, which is the point of least resistance, and there to emerge, contaminating the air in the building above. These facts account for the disagreeable cellarlike air so noticeable in unventilated basements and closed rooms on the ground floor.

There is a greater upward movement of the air during the latter part of the night and in the early morning than during the warmer parts of the day. The reason for this is clear. The air above ground is cooled more quickly and likewise warmed more quickly than that within the soil. So at night, when the air above ground becomes cooler and therefore heavier than the ground air, it tends to sink into the ground, thereby driving out the warmer, lighter air with its acquired impurities. This, as explained above, will accumulate in basements and lower rooms, so that especial care must be exercised in ventilating the parts of a building within reach of this foul air. On this point Doctor Bergey, one of the most critical students of hygiene in our country, says:

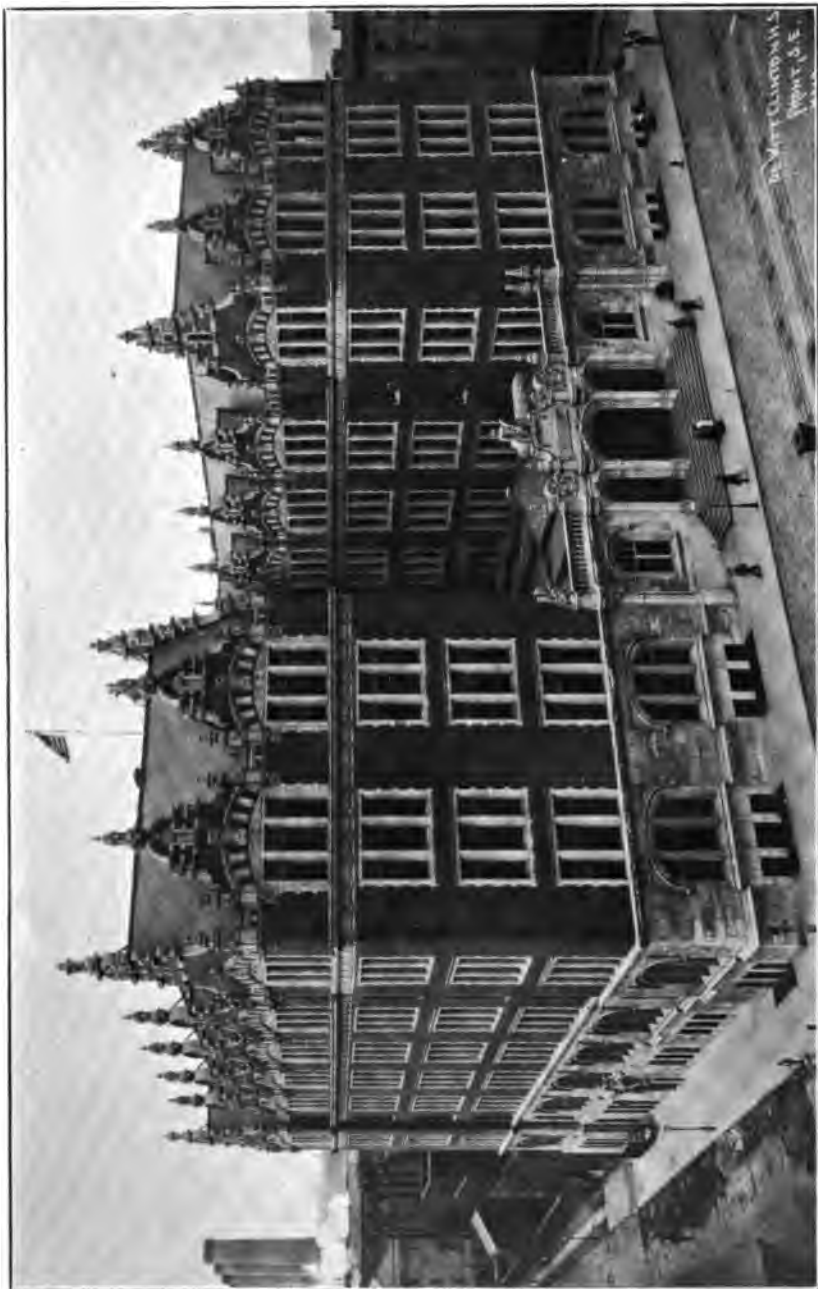
Ground air is usually rich in carbon dioxid, derived from decomposing organic matter in the soil. It is also very moist, because there is usually plenty of opportunity to take up moisture. It also contains decomposition products, such as marsh gas, hydrogen sulphid, and ammonia. This air is consequently not suitable for respiratory purposes. The amount of soil air

that gains access to houses under ordinary conditions is, however, so small that its influence probably is not felt. In newly made soils, in which there is considerable decaying organic matter, there is some danger of the entrance of large amounts of ground air into houses built on such soils unless special provision is made to exclude it. In such houses there should be cemented foundation walls and cellars, and the supply of fresh air should be derived from the outside at some distance above the ground. Unless the foundation walls and cellars are cemented, the houses when warmed may serve as an immense chimney in extracting the air from the surrounding soil. (Bergey, "Principles of Hygiene," pp. 332-333.)

It follows from what has been said about this matter of ground air and its impurities that the drainage of school grounds is an important consideration. In the first place it is unwise to select a school site which receives the surface drainage of any contiguous ground, and especially if such ground is exposed or has been recently exposed to pollution from any source. Other conditions equal, it is always safer to select a site higher than any land in the immediate neighborhood. This, however, is often impossible. Schoolhouses must be built at times on flat ground, because there is no other place available. Where there is thus no choice in the matter of elevation, much future difficulty may be avoided by taking into account the relative opportunities for underdrainage and contiguous sources of surface contamination.

Where there is sufficient outlet for tile drains, it is a comparatively easy matter to make the school lot more healthful by a system of underdrainage. The soil is not only freed in this way from undue ground water, but it is also rendered more permeable, and it, therefore, more quickly purifies itself. This method of drainage to some extent prevents the dangerous fluctuations in the ground water. Various rules have been given regarding the maximum height to which ground water should be allowed to rise. Taking all things into consideration, it seems that if the drains are laid 4 to 6 feet below the surface any danger resulting from water-soaked ground would be avoided. This underdraining is rarely an expensive operation, and hence there can be no objection to it on the score of lack of funds.

In the selection of schoolhouse sites in cities and towns, great care should be exercised to ascertain whether the soil is natural or made. It is not unusual to find that vacant lots have been used as dumping grounds for all sorts of corrupting materials. If ground so contaminated must be selected, the safe thing to do is to scrape up this material and the soil it has infected and cart it away, replacing it with natural soil of a gravelly or sandy nature. To cover up such refuse with permeable soil, only insures the long continuance of poisonous exhalations.



DE WITT CLINTON HIGH SCHOOL, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT. THIS HAS BEEN DESIGNATED "THE FINEST HIGH SCHOOL BUILDING IN AMERICA."





SCENE ON PLAYGROUNDS, POPLAR BLUFF (MO.) PUBLIC SCHOOLS. HERE IS A GOOD BEGINNING.



NEW HIGH SCHOOL, MARSHALL, MO. THIS BUILDING WILL HAVE GOOD LIGHT AND CLEAN AIR, AND WILL NOT BE DAMP. (FOR PLANS SEE PL. 129.)



POMONA (CAL.) HIGH SCHOOL.

During rainy weather, the soil not only becomes saturated with moisture, but it also necessarily becomes less porous, thus tending to increase the flow of outgoing air toward the dryer spot covered by the building. This, of course, would add to the difficulty of preserving the requisite purity of the air to be used in the schoolroom. It has been found that "the air which fills the soil to a depth from 5 to 10 meters and makes up almost one-third its volume, can, even if it move but slowly, rise therefrom in the course of a single night so as to constitute, with its contained moist foul gases, a considerable portion of the atmosphere of our dwellings, courts, and streets." (Copeman, "A Treatise on Hygiene and Public Health," edited by Stevenson and Murphy, Vol. I, p. 322.)

As the result of many investigations in England and on the Continent, it has been found that diphtheria, phthisis, and malarial diseases are more prevalent where the soil is damp than where the soil is dryer and porous, and that this difference is emphasized when the soil receives the drainage of contiguous ground. Doctor Thursfield has pointed out that dampness of houses due to the nearness of the subsoil water to the surface is closely connected with epidemics of diphtheria. Doctor Bowditch, in speaking of the dangers to the health of those living on damp marshy ground, says, "Massachusetts, through the agency of the Massachusetts Medical Society, proved, many years ago, by data received from her 325 towns, that where consumption had been previously considered everywhere equally endemic, there were dry spots where it was very rare and wet where it was very rife. By accurate statistical data, laboriously gathered, it was further proved that, of two families growing up, one on a wet soil and the other on a dry soil, the one resident on the wet, by that fact, became twice, if not three times, as liable to phthisis as the other resident on a dry spot. That law was first discovered and announced in New England. Subsequently, by ample statistical data, it was proved to exist in Old England. I think it may now be said to be a cosmic law." (Bowditch, "Public Hygiene in America," p. 119.)

Since this statement was made by Dr. Bowditch of course great advances have been made in determining the cause of diseases, but what he said is as true to-day with regard to conditions as it was then. Many parts of our country—for example, the far West and Southwest—are peculiarly free from the difficulties which have been mentioned, but certain districts in these States are not so fortunate. In the hot valleys where irrigation is employed we have had striking illustrations of what must happen when the laws of hygienic conditions touching schoolhouses are neglected.

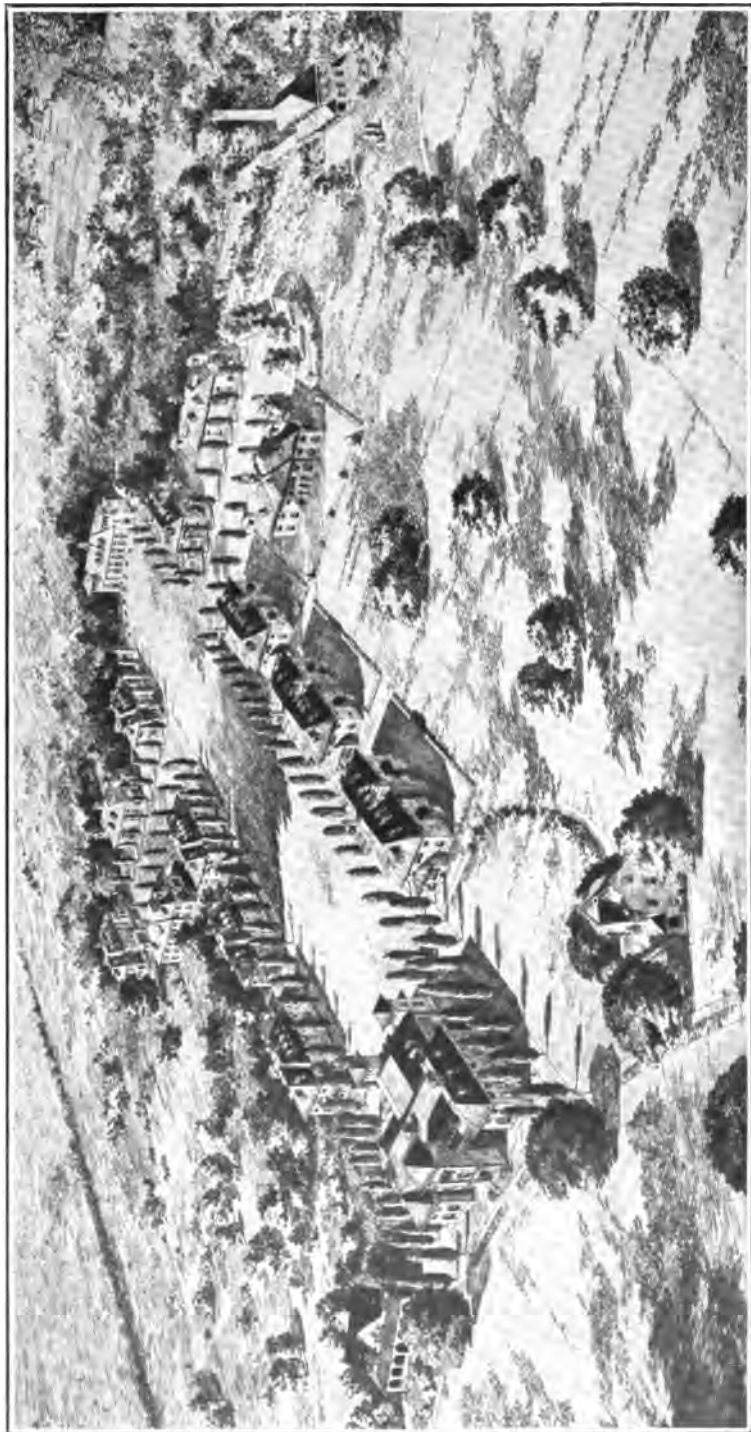
In those parts of our country where irrigation is necessary for agricultural success cool nights and hot days generally prevail. It

is not at all unusual in such districts to experience a regular difference of  $30^{\circ}$  F. between the temperature of the middle of the day and that at night. This great daily fluctuation is due to the fact that during the day the sun's rays are not impeded by a blanket of moisture in the air, and hence the ground becomes very warm; but because of the absence of this same blanket of moisture, as soon as the sun goes down the radiation of the heat from the earth is extremely rapid, and the night air becomes cool, or even cold. Consequently the air shrinks, becomes heavier, and presses into the soil, driving out the warmer and moister air. Under such conditions it is not strange to find the earth breathing deeper, as it were, and with more force during the night. It takes in the air through every available opening and drives out that which it has held during the day. The air thus driven out will naturally find exit through those openings offering least resistance. From those parts of the ground which retain the heat longest there will be an upward draft, which acts as a chimney to draw toward it the warm air under the ground. Hence basements under buildings, or the ground immediately about buildings not undercellared, will act as aspirating flues for the contiguous soil. From what has been said it will be readily seen that irrigated districts suffer more from the dangers of ground air than those where the air above ground contains more moisture per cubic foot, and so retains a more even temperature night and day. School buildings in such climates demand thorough ventilation before school begins in the mornings, and the basements beneath them must be provided with means of preventing as much as possible the entrance of this ground air, and also abundant opportunity for getting rid of all that may find entrance despite all efforts to keep it back. This point will be further considered under the discussion of basements.

There is another difficulty arising under such conditions that is not often considered. The air thus driven out carries with it a much greater amount of aqueous vapor than is found in the air above ground. Hence the foundations and lower parts of buildings so situated are exposed to an undue supply of moisture, while the upper parts are unusually dry. There is offered, then, greater opportunity for the ground air to pass out through the buildings, and also, by reason of the increased force of capillarity thus brought about, to draw moisture from the ground through the walls. I have known buildings situated in such ground to "sweat" during the nights to such a marked degree that the plaster on the walls of the lower rooms soon became disintegrated and loosened from the laths. Under the influence of this excess of moisture, blackboards made of wood or hyloplate will warp and buckle, those of cement or plaster will chip, and those of slate will collect moisture and in time become saturated with impurities. Furthermore, timbers in contact with the walls



McMILLAN HIGH SCHOOL, MEXICO, MO. A MODERN TWELVE-ROOM BUILDING WHICH GIVES PROMISE OF A QUIET AND RESTFUL PLACE IN WHICH TO WORK. (FOR PLANS, SEE PL. 130.)



BIRD'S-EYE VIEW OF PARENTAL HOME SCHOOL, FLUSHING, N. Y. C. B. J. SNYDER, ARCHITECT. "BLESSED ARE THE UNFORTUNATES."



A. CONSOLIDATION OF SCHOOLS IN MINNESOTA. THIS IS THE WAY PUPILS FORMERLY CAME TO SCHOOL IN THE LANGDON DISTRICT.



B. SCHOOL VAN NOW USED FOR CARRYING PUPILS TO SCHOOL IN THE SAME DISTRICT.





will rot quickly and in a short time endanger the structure. I know of a brick building built on the ground where the water line was kept at about 6 feet from the surface by the irrigation of the surrounding country. In six years, and almost before the danger was discovered, the timbers supporting the floors had so decayed that the whole of the lower floor was ready to drop into the basement. The building was condemned and had to be reconstructed at large expense. It is only fair to say that the foundation walls were constructed of unglazed bricks and no damp proofing had been used. I have called special attention to these difficulties in irrigated districts because the dangers here are written large; but it must not be forgotten that the same principles apply everywhere. In cold climates where the ground is frozen to a depth of a foot or more and remains so for months, basements, wells, sewer openings, etc., offer about the only blowholes through which the ground air from below the frost line can be forced out. The heavy cold air prevailing outside will find fewer points of entrance, but because of the immense pressure it exerts must find its way into the soil. Hence warm buildings, because they protect the ground under them and prevent it from freezing, and because all the heat generated in them must in time escape into the air above and around them, act as exhaust ducts toward which ground air will be drawn for even long distances.

Every observant person who has lived in cold climates has noticed how an open well will "smoke" in cold weather. This phenomenon illustrates the movement of ground air toward the well, and the higher percentage of saturation in such air than that above ground. When the vapor carried by the outflowing air strikes the cold air above ground, the moisture condenses and becomes visible. Here we have a simple visible illustration of what is occurring in a far more pronounced though invisible way through basements and houses, when, by the draft produced through the escaping currents of heat from the house, a partial vacuum is formed under it and all about it.

The plain duty, then, of all who have responsibility in locating schoolhouses is to understand the facts here presented and to know that ground air carries many impurities. The attempt of any school board to locate a school building on water-soaked land or that contiguous to infected soil is a civic blunder that any intelligent community ought to resent with all its might and thwart without fail. If men or women who do not know what to do are elected to membership in school boards, then it is the duty of boards of health to furnish this information. Somewhere in every school curriculum there ought to be a place to teach these facts to the children, for they have to do with homes as well as schools.

Another very important question concerning the location of schools, especially in cities and villages, has to do with the avoidance of disturbing noises. It is a far more serious error to locate school buildings near railways, noisy factories, or busy thoroughfares than a first thought would seem to indicate. The rattle and roar of a noisy train or of a heavy wagon not only tends to disturb the pupils while at study, but it is impossible to carry on a recitation in a satisfactory manner during such distractions. It may be argued that children soon get used to all such noises and pay little attention to them. Indeed, we have had thoughtful people tell us that it is good for children, for it teaches them to concentrate their thoughts, and thereby to neglect those things irrelevant to their work. But it must be remembered that although we learn to disregard very much of the stimulus with which we are constantly assailed, our nervous systems are continually exposed and irritated. There is a persistent demand and drain on the nervous system notwithstanding the mind may apparently be at ease. With most children mental concentration is an utter impossibility when distractions are present. The characteristic and normal attitude of children is one of fluctuation. They are drawn hither and thither by almost every passing stimulus; hence any unnecessary excitement should be avoided. The educational demands made upon the children of to-day are sufficiently great to exact of them all the energy available, and it is little less than criminal to place them in conditions that compel them to waste their energy. Most children who live in the larger cities are never in repose. They are bathed in this constant turmoil of noise both day and night, and, as a result, their nervous systems are levied upon incessantly to no purpose at all. Complete and undisturbed repose is a prime essential to good health, and especially to the normal growth and development of nervously inclined children.

The rapid growth of modern cities suggests that in the near future radical changes must be made in the selection of school locations. The increasing values assigned to land near congested centers will of necessity limit the school grounds to the smallest possible space and tend to enforce the construction of taller buildings. With such restriction in the size of school lots the danger of fire will be greater, while noises, dust, and dirt will, in all probability, increase proportionately.

It would be more economical and far more hygienic for cities to set apart certain large areas in healthful localities, and use these for the sites of many school buildings, and, if need be, furnish free transportation to those children whose homes are at too great a distance from the schools. Massachusetts spends annually thousands of dollars for the transportation of those who live too far from the village schools, yet in so doing she is saving money and securing for

BUREAU OF EDUCATION

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her country children better accommodations both hygienically and educationally. In large cities there are always many school buildings located upon land whose value for commercial and other purposes is very great. The difference between the market value of such property and larger lots at some distance from the center of the district would, if put at interest, yield sufficient revenue to pay all expenses for transportation.

If the reader is inclined to think that it is not worth while for children to get out into the fresh air of the country, away from the dirt, dust, and noise of a great city, or even a busy town, let him examine the vegetation in each place and see what story the leaves can tell. Gather some leaves from a shade tree exposed to the smoke and dust of a city and some from the same kind of a tree in the open country. Even the trees of a smoky city are soon suffocated. The leaves are coated with dust and soot, which the rains can not remove. They are thus choked and starved. Look at the leaves represented in the illustration (Plate 9 *A, B*) and know that the children who live in the city from which these were taken rarely if ever get a clean breath of air. Can you expect them to become clean, strong, vigorous, and healthful? If you do, you expect more of them than the trees can accomplish. But city trees have no sense of smell to trouble them, no lungs to catch and hold myriads of bacteria lint and nauseating filth, and no ear drums to split. Moreover, they get more baths than many children, and yet they soon weaken and decay and never reach full maturity. When the storms come, they are crippled and maimed and, sooner or later, prematurely die. Look at the English sparrow. He belongs to the city and city life. He is noisy, fussy, dirty, untidy, and a scavenger. Contrast him with the song sparrow of the fields, and you will see what city life can do even for a bird. He has lost his song, is impudent, selfish, and altogether a degenerate. While he appears quite vigorous, it is simply rush and fuss and fight. His mortality is high, and when you least expect it you find him dead.

It is often very difficult to secure proper light in the class rooms when the school building is situated in close proximity to tall buildings. Either the light will be partly shut off or the reflections will annoy and harm the vision. For the first reason it is a mistake to build too near a hillside. Unless each child can see some part of the sky while at his desk, the probabilities are that the light will be insufficient. Tall buildings and high hills so raise the horizon line that those who are sitting farthest away from the windows in school rooms so placed labor at a great disadvantage.

Inflammable buildings are unsafe neighbors to a schoolhouse on account of the dangers incident to fires.

After a site has been selected, much trouble may be prevented by carefully considering the location and orientation of the building on the lot. To those who have not taught in schools, these points will scarcely appeal in the light of their real importance. But the fact is that the proper lighting of a schoolroom and the usefulness of the average limited playground depend very largely on the way the building is placed on the lot.

If possible, the windows of a schoolroom ought to open toward the east or west, never toward the south, and only in a few cases toward the north. Special reasons will be given for this preference in the discussion of the subject of lighting. It is enough here to remark that no amount of afteradjustment can overcome the difficulties introduced by facing the windows in the wrong direction.

In most climates the playground ought to be so exposed to the direct sunshine during the school year as to prevent, as far as possible, a damp or muddy surface. When the building is properly placed on the lot, the playground is not divided, and at the same time the sunshine is given free access to it.

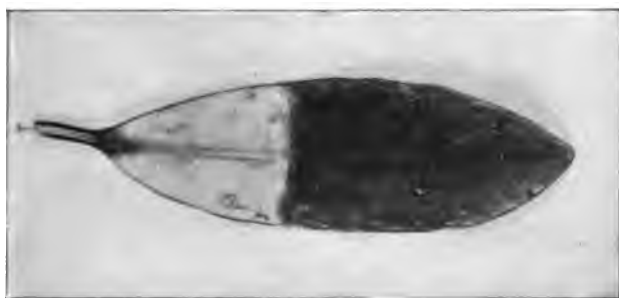
For these reasons it is best to put the house either on the west or north side of the lot, removing it from the street or roadway a sufficient distance to avoid the noise and dust caused by passing vehicles.

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### FOUNDATIONS.

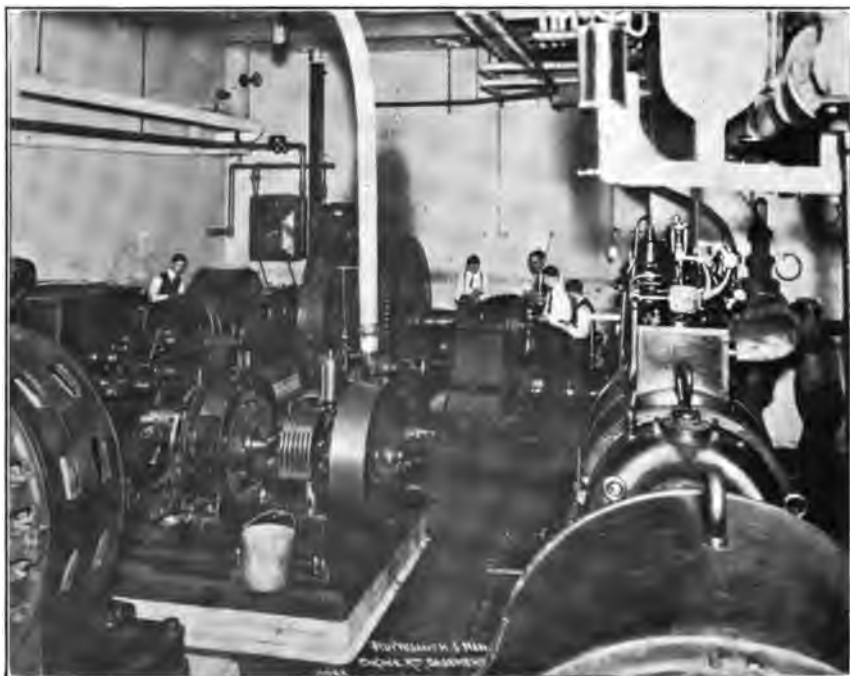
It is not my intention to discuss technically under this caption the strength of foundations, or, for that matter, the best materials to be used. I prefer to assume that the architect and builder will settle all such questions. The one consideration connected with the foundations of school buildings which I wish to emphasize here is the one architects and builders often overlook. It is this: How can the foundations of our brick, stone, concrete, and wooden schoolhouses be so constructed that the walls above ground will not, through capillary attraction, convey moisture from the earth and in this way introduce unhygienic conditions into the schoolroom, which are evidenced by "sweating" blackboards, discolored walls, rotting floors and supports, and that cold, clammy atmosphere most noticeable in the morning when the schoolhouse is first opened?

It is plain that the amount of moisture in the walls will depend not only upon the construction of the foundation, but also upon the amount of water contained in the ground in contact with the foundation. If it were always possible to build upon bedrock, careful drainage around the building would forestall nearly all of the difficulty; but as this is only rarely possible, other means must be employed.



**A AND B.**—PHOTOGRAPHS OF LEAVES SHOWING DEPOSIT OF SOOT; HALF REMOVED.  
FROM "THE AIR OF TOWNS," BY DR. J. B. COHEN; BY THE COURTESY OF THE  
SMITHSONIAN INSTITUTION, WASHINGTON, D. C.





**A. ENGINE-ROOM IN BASEMENT, STUYVESANT HIGH SCHOOL, NEW YORK CITY.**



**B. BOILERS, ETC., IN BASEMENT, PUBLIC SCHOOL NO. 62, NEW YORK CITY.**

Concrete foundations with good wide footings are doubtless the best which can be used and when made with scientific care are much less porous than brick. But there must be a layer of some indestructible material, impervious to water, built into all basement walls and piers, otherwise dampness will find its way into the rooms above. Furthermore, this layer must of course be above ground, must be entirely hidden or inconspicuous, and must in no way detract from the strength or permanency of the walls.

It has been found that a thin layer of slate embedded in rich, fine cement mortar will break the capillarity in a wall of cement, stone, or bricks and thereby prevent the moisture from the ground rising above it. This material has also the advantage of strength and endurance. It has also been found that a thin layer or coating of hard asphaltum embedded in the walls will serve the same purpose and will in no way impair the strength of the walls. These damp-proof layers are not expensive, especially if asphaltum is used, and there is no reason why they should be left out. Even a layer of tarred paper on the top of a wall will be of some service for years. Perhaps the best method of damp proofing foundations consists in the use of a thin layer of 1 to 1 cement. In addition the outside of all basement walls below ground should be coated with boiling tar or asphaltum before excavations are filled, for this will materially aid in preventing the absorption of the ground water by the walls, especially during rainy weather. Where basements are built this is a necessity, if the air within them is to be kept at all wholesome.

The figure on the following page will make clear the points herein enumerated.

Not only do rainstorms beat against the outer walls of a building and saturate them, especially if they are of brick, but frequently caves are not supplied with gutters and spouts to carry away from the building the water shed from the roof. When this is the case it is certain that the walls of the upper part of basements will be saturated, even though the normal water line is much below all parts of the foundation.

The safe thing, therefore, is to provide all school buildings (dwellings as well) with strong, durable eave gutters, and a sufficient number of down pipes to carry off the water from even the hardest rains. These down pipes should empty into impervious earthen pipes or cement drains, so that the water will be delivered at a safe distance from the walls. It is very poor economy to provide gutters and pipes and then let the water pour on the ground at every corner of the house. In flat, damp land where the water line is comparatively near the surface of the ground especial care is needed. I have already mentioned that schoolhouses situated in the irrigated sections of some of the Western States sometimes collapse after comparatively few years of service, because the foundation walls extend of necessity

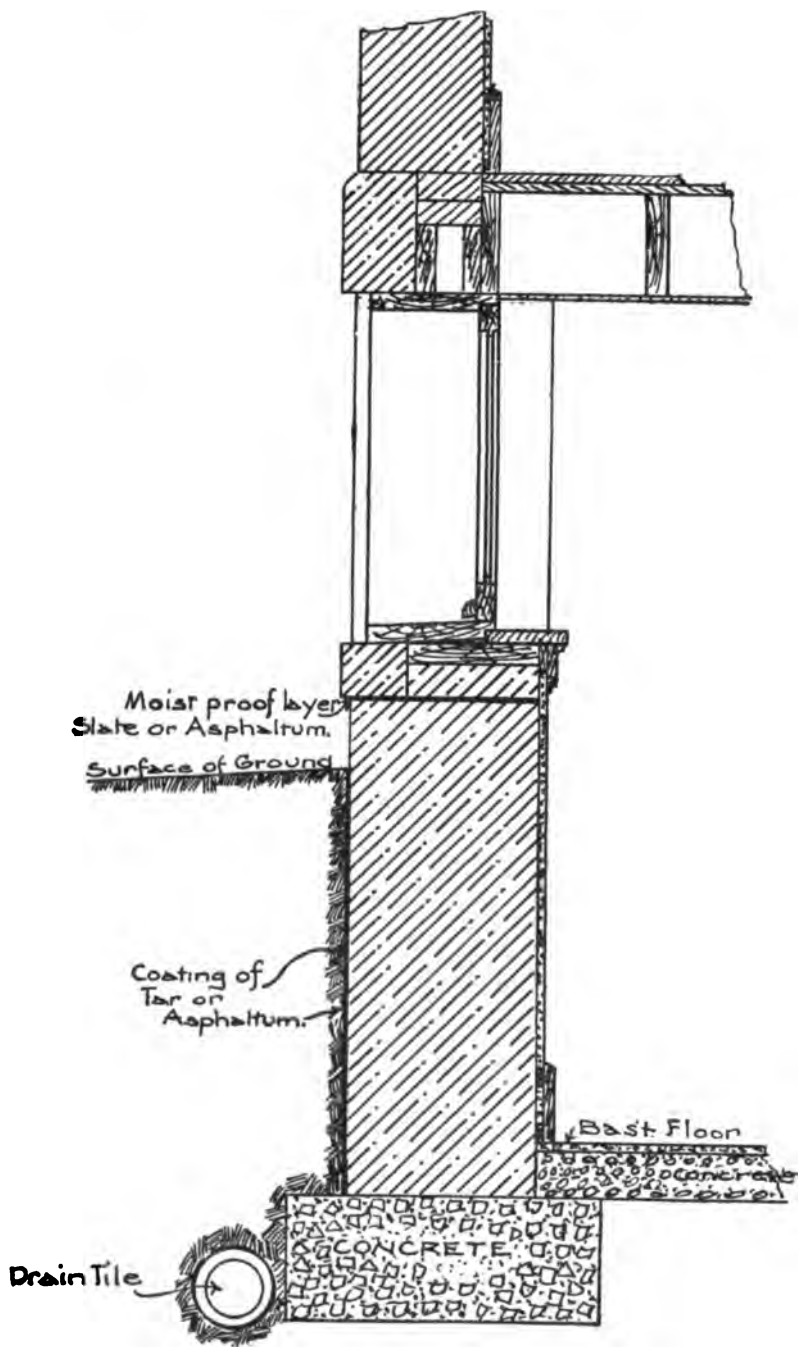


FIG. 1.—Section of foundation.

below or near to the water line, and, therefrom bring up so much moisture as to rot the floor joists and all woodwork in contact with the upper walls. While this is expensive and even dangerous, it is the smallest part of the difficulty. Cold, clammy walls and damp, chilly air make the rooms on the first floor unwholesome and uncomfortable. Rooms so exposed are hard to ventilate, difficult to warm, and a constant menace to the health of the children and teachers.

*Drainage.*—Schoolhouses should never be located where it is impossible to get a free and easy outlet for a drain through which the water line about the building may be kept always below the foundations and basement floors. The tiles for this drain should be of the earthen sort, well burned so they will resist decay and safely bear all strain to which they may be subjected. The joints should be left slightly open below and covered for some inches with coarse gravel or broken stone. It is a useless expense to fill the entire excavation with gravel or stone, for almost all the water finding its way into the tiles rises and enters at the bottom of the drain. The only need for gravel or broken stone at all arises from the fact that if the soil is sandy or a loose loam there is danger that enough of it will enter the joints in time to clog the drain. If the joints are sufficiently protected with coarse gravel or bits of broken stone to prevent the surrounding soil from entering, all requirements in this regard have been met. Almost no water drops directly down to the drain, and especially so if the ground surrounding the building slopes away from it, thus carrying surface water away from the walls. This drain should always be placed lower in the ground than the foundations, so that the water line will never reach the walls for any length of time.

This precaution is absolutely necessary for all buildings with a basement, for unless the water line is kept below the level of the floor of the basement it will be impossible to prevent water from rising in it. It is a mistaken notion, and a very common one, too, that if a basement is thoroughly cemented, both floor and walls, no water can get into it. Contrary to the belief of a great many people who are just beginning their experience with cement, it is not impervious to water, and under a comparatively slight pressure water will readily find its way through well set and carefully made cement floors. Unless, therefore, those who introduce basement floors into a school building have placed the building on high land, with the ground sloping away from it rapidly in all directions, they must encircle it with a drain as indicated in figure 1, or it is perfectly certain that no reasonable amount of cementing within will prevent the water from entering. I am insistent on this point, for the reason that I have seen almost no end of trouble and much unexpected expense grow out of neglect in this matter. It is not expensive, save in rare cases where buildings are badly placed, to drain the ground as

indicated. The tiles needed are only such as farmers use in under-draining land, and the labor required to put them down can be done by any ordinary workman, with the exception of the leveling, and even this requires no expert service in many cases. Generally speaking, such drains save more than they cost. For when these are properly placed a great deal less care is required in finishing the basement, and often much expense in cement work can be saved.

It is never well to run drains under a basement floor, especially if they connect directly with a sewer system. In fact, it is unsafe to connect the outside drains with sewers, for the gases and odors given off by sewage will filter through the ground and render it unwholesome. All drains then should come to the surface, or empty into a trap, rendering it impossible for sewer gas to collect in or about schoolhouses. Furthermore, it is wholly unnecessary, even in the case of large buildings, to put any drains under the building, if drains have been placed all around them and deeper than the foundations or basement floors; for, since the ground under the building is protected from rains, no moisture can gather there unless it comes from the outside and is either forced up by the pressure of the water on higher ground or pours in from the surface. But a drain outside will relieve all pressure from below and ordinary embankments will protect from surface water.

This drain should be about 6 or 8 feet outside the foundation walls, and if the tiles are sufficiently large and the drain has a sufficient fall to its outlet, the down pipes from the eave spouts can be made to deliver their water into them through solid and thoroughly water-proofed metal pipes. In this way all roof water can be quickly carried away. Common sense will teach those who undertake this to avoid overfeeding the drain pipes and to make sure the leaves and soot, which often gather on roofs in the fall time, do not clog the drains. Sometimes in large and irregularly shaped buildings it is necessary to introduce laterals into the main drain in order to insure rapid, safe, and complete drainage of the ground all about the schoolhouse, but this can be left to the judgment of the architect to be treated as the exigencies of the situation demand.

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### BASEMENTS.

It is highly advisable that a basement be constructed under all school buildings which are situated where adequate drainage can be provided. There are several reasons why this should be done, chief among which are the following:

(a) A basement provides the best location for engine rooms and a central heating and ventilating plant. The noise and dirt incident

to maintaining fires, removing ashes, and preparing fuel are least disturbing here, while the ducts designed to carry the warm air from furnaces or steam pipes from boilers, can be delivered into the class rooms more economically and effectively than if they had their source outside of the building.<sup>a</sup>

(b) From the point of view of economy in construction there is a great saving, for under ordinary conditions at the same expense much more space can be provided in a basement than in any other part of the building.

(c) A well-constructed basement provided with good means of ventilation and underdrainage is one of the most effective agencies in preventing the rise of moisture in the walls and ground air into the classrooms and halls.

(d) A basement provides the best place for playrooms, lavatories, and bathing facilities, when these must be located in the building. It gives ample space for all the necessary plumbing and at the same time renders it easily accessible. Naturally playrooms in basements are to be used only during inclement weather, if outside playgrounds are furnished.

(e) Rooms for manual training, especially iron and wood work, can be located in good basements, if for financial and other reasons these can not be furnished in specially constructed buildings or conveniently located in the same building above the basement.

(f) Basements are generally used for the location of urinals and closets. No one will say, I think, that this is an ideal location for them; but when due care is taken and good systems are correctly installed and intelligently kept there can not be very grave faults found with such location. There are some advantages and some disadvantages. One advantage lies in the ease with which they can be isolated, another their accessibility from playgrounds, and still another that children are protected from exposure during bad weather. Perhaps the most important advantage, however, is that when situated in basements, by reason of the fact that they can be connected easily with the heating and ventilating systems, they can be kept thoroughly sanitary. Further discussion of this topic will be given under the topic of toilets and urinals.

The ceilings of all basements should be at least 10 feet high, with not more than 3 feet of excavation. Even this is too deep if the soil is damp and the ground-water line high. For example, experience with a well-built modern high-school building situated on alluvial soil, with a long sloping rise behind it, taught me that the rush of water through such soil in wet weather is very difficult to meet.

<sup>a</sup> State law of Utah provides that "No schoolhouse shall hereafter be built with the furnace or heating apparatus in the basement or immediately under such school building." (Chap. 32, sec. 1, Laws, 1909.)

A thick cement floor would not keep it out, though the excavation was not greater than  $3\frac{1}{2}$  feet deep. Proper drainage, however, brought relief.

On ground easily drained and higher than that anywhere in the immediate neighborhood it may be advisable, for the sake of appearance and expense, to go a little deeper, but this will have to be determined by local situations and local needs.

If basement floors are nearer the first-floor joists than 10 feet it will be difficult to install the plumbing and the air ducts for heating and ventilation without placing them so low that they will interfere with the heads of teachers and janitors, and at the same time offer opportunity for the children in their play to hit them "just for fun." It should be remembered that if air is to be delivered economically into schoolrooms there must be large ducts, well protected from cold and with no sharp turns or elbows. The failure to do this has rendered many expensive heating and ventilating plants unsatisfactory. Invariably, if the basement ceiling is too low, sacrifices will be made in the inclination and size of these ducts, and if not rendered seriously defective they will necessitate more power to deliver the air needed. And just here it is well to emphasize the fact that basement plans deserve a great deal of study before they have been finally accepted. In fact definite plans and specifications for basements ought to include all the plumbing, furnaces, air ducts, etc., in order that one can see exactly what the completed basement will include, where every appliance will be placed, and how it will fit. Failure to do this leads to many maladjustments which give trouble from the very start. For example, suppose the schoolhouse is to be near a busy street whence much dust is raised by passing vehicles. At once one will say that no air should be drawn from that side of the building into the schoolrooms, and that the basement arrangements must be made to meet this demand. Economy and practical sense both dictate an arrangement of the intake that will take advantage of the prevailing wind and not compel the fan to work against it. It is sometimes advisable to supply two openings for the intake of fresh air so as to be able to use the one best suited to the conditions of the day. These openings, as explained elsewhere (p. 100), ought to be sufficiently above the ground to avoid dust and possible ground air.

On the whole, a good quality of cement makes the best floors for basements. Asphaltum can be used, but it is more likely to become rough and uneven and is more difficult to lay evenly and level. Still, it is more impervious to the rise of ground air than cement.

If finances will permit, the basement walls can be veneered with glazed light-colored brick or tile to good advantage. This treatment will greatly increase the light, render the walls more sanitary, and invite less defacement. Such walls are easily cleaned and kept



WASH ROOM, MANUAL TRAINING SCHOOL, HIGH SCHOOL, BROOKLINE, MASS.





FORGING LABORATORY, MANUAL TRAINING SCHOOL, BROOKLINE, MASS.



MANUAL TRAINING BUILDING, HIGH SCHOOL, BROOKLINE. CARPENTRY AND JOINERY LABORATORY.

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bright and fresh. This treatment of toilet rooms, wash rooms, and bathrooms is especially recommended.

Too much pains can not be taken in placing piers and walls in basements so as to intercept as little light as possible. Frequently, instead of a solid supporting wall, piers supporting heavy iron cross beams can be used, thereby rendering the basement more open and airy and increasing the light. Sometimes arches can be constructed of brick or concrete, accomplishing the same ends without in any way increasing the expense or weakening the building.

I recommend a careful study of all basement plans reproduced in this bulletin. Some suggestion at least will be gained from each one of them.

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### THE CLASS ROOM.

The primary unit of a school building is the class room, and no definite plans for a building can be thought out until a decision has been reached as to the size, form, and number of class rooms desired. Since the number will vary to suit local conditions, it is not necessary at this time to discuss this point; but the size and form of class rooms are matters which ought to be decided in accordance with hygienic and pedagogical principles, and it is necessary to consider these points rather carefully.

The size of the class room for elementary school purposes ought to approximate the following requirements:

1. It should be sufficiently large to seat properly from 40 to 45 pupils, and at the same time have sufficient space left for aisles and the requisite furniture and apparatus. This limit as to the number of pupils is based on the theory that no teacher ought to be asked to teach more than 40 or 45 pupils, even though they all belong to the same grade and are doing approximately the same work. Even these numbers are too large for the best work; but there seems to be no immediate probability of reducing them. It is not at all infrequent, however, to find more than 50 pupils to a class room in the intermediate grades. One effective way to make this impossible is to make the room of such a size that when the seats for 40 or 45 pupils are properly placed there will be no room left for crowding in any more. This may seem a rather indirect way to prevent overcrowding in a room, but all practical schoolmen know that as long as there is room for more, they are likely to be crowded in. A room 24 feet wide and 32 feet long will comfortably seat this number, allowing ample room for aisles, blackboard workers, and room for reference table, sand tables, or any other pieces of apparatus regularly needed.

In the District of Columbia the class rooms in the buildings erected in recent years are 24 to 25 by 32 or 33 feet. Ceilings are 13 feet high. Such a room contains about 250 cubic feet per pupil, on the average attendance of 42 pupils per room. (Report of School-house Commission, 1908, S. Doc. No. 338, p. 23.)

The standard schoolroom of the city of Boston, Mass., is about 26 by 30 feet by 13 feet high, and contains desks for some 50 scholars. (Boston School Document No. 14, 1907, p. 8.)

2. A class room must not be so long that a pupil seated in the back of the room will have any difficulty in seeing easily and distinctly any ordinarily clear writings or drawings which the teacher may place upon the board in the front of the room, or such charts and models as are often used for the instruction of the whole class. It has been found by careful experimentation that the distance at which a normal eye can easily see well written or printed letters an inch and a half high, is about 29 feet. Burgerstein says: "According to my experience the distance at which a normal eye can see script 4 centimeters high, written rather heavily on a blackboard, is 9 meters (29½ feet)." He concludes that it would be a good thing therefore to limit the maximum length of a school room to 9 meters. (*Handbuch der Schulhygiene*, Burgerstein and Netolitzky, second edition, 1902, p. 116.)

Burgerstein says in a later book that all things considered one will find that a class room 9 meters (29½ feet) long, 6 meters (19½ feet) broad, and 4 meters (little over 13 feet) high is about the proper size for serviceable use. (*Schulhygiene (Aus Natur und Geisteswelt)* 1906, Leo Burgerstein, p. 31.)

He says such a room will accommodate double benches for 50 pupils. His reasons for this size of room are normal requirements for vision, hearing, and the depth to which light will carry.

Schmid-Monnard and Schmidt practically agree with Burgerstein. They suggest that the width might be extended to 6½ meters (21 feet 4 inches). (*Schulgesundheitspflege, Ein Handbuch für Lehrer, Ärzte und Verwaltungs-Beamte*. Leipzig, 1902. p. 14.)

A room of this length will make it easy for a child who sits in a rear seat to hear distinctly when the teacher at the other end of the room speaks in a clear, distinct voice with moderate force and natural intonation. In the primary grades especially a large part of the instruction must of necessity be given orally, and since the children must hear the words of the mother tongue accurately if they are expected to learn to speak them correctly, it is of vital importance that their class rooms be adjusted to this demand. Unfortunately many teachers have failed to cultivate a speaking voice that will carry well and at the same time maintain a good tone with distinctness. Poor spelling frequently results from inaccurate pronunciation and

faulty articulation. This defect in school work was made clear by the investigations of Miss Wiltse, who found poor hearing responsible for much bad spelling. (Proc. N. E. A., 1892.)

It has been found by observation and careful investigation that the ordinary speaking voice, such as should be used in a schoolroom, will not carry with sufficient force beyond 30 feet to enable normal children to hear easily and accurately. It is very tiresome to have to strive to hear what is said, and the fatigue resulting from continued effort to hear is harmfully annoying and distracting. Furthermore, no teacher should be kept in a schoolroom that makes it necessary for her to unduly tire her voice or waste her time in repeating. An overwrought rasping voice has an irritating effect on the children.

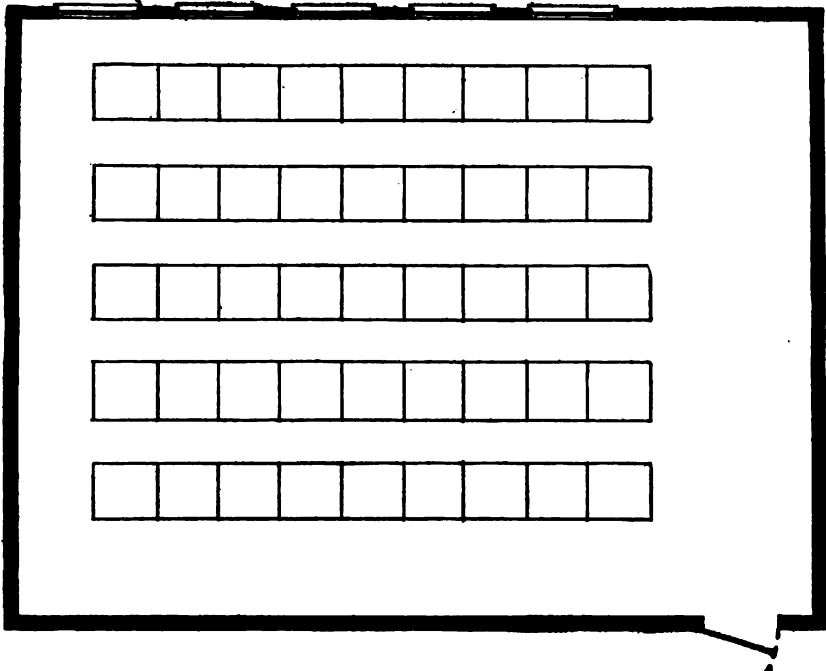


FIG. 2.—A schoolroom 24 by 32 feet, showing position of windows and desks, width of aisles, etc.

In the length of the room proposed I have allowed "ample room" for blackboard workers, for aisles, and for tables at the teacher's end of the room. By leaving an aisle 3 feet wide behind the last row of seats the pupils farthest from the teacher are well within hearing and seeing distance. In a shorter room there would not be space enough for passing and for work at the board, and especially so if, as it often happens, the cloakroom must be placed adjoining the rear end of the class room. Figure 2 illustrates a room of the length and width proposed, with the location of desks, the width of aisles, and the space at the teacher's end of the room.

3. The width of the schoolroom, where unilateral lighting is used, should never exceed twice the distance from the floor to the top of the windows, and where external conditions are unfavorable for good light even this width is too great. Most German authorities insist that the width of the room should not be greater than one and one-half times the distance from the floor to the top of the windows, and this demand is repeated by those already quoted. Naturally the row of desks farthest removed from the windows will receive the least light, but by grouping the desks as close to the window as sufficient aisle space will permit, my experience is that in most parts of our country, 24 feet is not too great a width. This will permit ample space for 40 to 45 single desks and still leave room for aisles, space for the teacher, apparatus, and the workers at the blackboards. In case the light does not carry well across the room, prismatic glass set in the upper half of the windows will help very much. However, one must not forget that light decreases as the square of the distance increases, and that those pupils removed the greatest distance from the light are those, other things being equal, who need most attention when matters touching light are considered. Fortunately our country, as a whole, is better situated with reference to latitude than most European countries, especially England, Scandinavia, Germany, and Holland. In these countries the winter days are very short and the early morning and the afternoon light is dull and weak. We can get, on the average, I believe, better light during the winter season in a room 24 feet wide with the same dimensions of window surface than the Prussians can get with one 18 feet wide. I am certain that this is true for all of the southern and for most of the western part of our country.

4. The height of a standard class room should be determined after due consideration of several factors. In the first place the item of expense should be considered. Unless some real permanent and important pedagogic or architectural ends are to be gained, every foot saved in the height will reduce its cost much more than a casual calculation would indicate. If the building is to be constructed of brick, stone, or concrete, the cost of every foot increases with the height above the ground. For instance, if a 35-foot wall is required for the basement and two stories of class rooms, 1 foot more added to each story would cost more than a foot of the same wall lower in the building would cost. The cost would also be increased under certain conditions by reason of the need of making heavier walls, taller chimneys, longer and larger air ducts for heating and ventilation, and more extensive plumbing. Besides, every foot added to the height of a class room adds so much more expense in keeping it in repair, and especially in heating it.

The item of expense is not the most important factor for consideration, though I would not minimize it. Every foot added to the

height of the interior walls of a schoolroom lifts the floor of the story above 1 foot, thereby increasing the length of stairways and making it necessary for all pupils whose class rooms are above the first floor to climb that much higher. From the hygienic point of view there is no special disadvantage in this for the boys, but it is an added hardship on adolescent girls, especially during one week of every month for each one. In case of fire or earthquake there is also increased danger. There is a loss of time, and, if climbing stairs is disagreeable and tiresome to anæmic pupils, they will frequently remain in the class room during intermissions rather than go into the fresh air.

Besides, the matter of acoustics deserves attention. Echoes are very distressing in any public assembly room, but they are serious disturbances in class rooms. Other things equal, rooms with tall ceilings are more troublesome in this regard than are rooms with lower ceilings; but, so far as I know, architects have worked out no fast and safe rule which, if followed, will insure the best acoustic conditions. Since steel lath has been introduced for plastering, it seems that troublesome echoes are more in evidence than ever before, and every precaution should be taken to deaden the walls in school buildings to prevent this grave annoyance.

Nevertheless, it is necessary to make a class room sufficiently high to insure the proper placing of windows, an adequate area of glass surface, and the conditions necessary for suitable ventilation.

Having considered these points even briefly, it seems to me that we shall not err to any great degree if we recommend that a standard class room for the public elementary schools of our country should be 32 feet long, 24 feet wide, and  $12\frac{1}{2}$  feet high from finished floor to finished ceiling.

I am aware that the floor surface of this room is a little larger than that recommended by some recent works on school architecture, and that the height of the ceiling is less than that recommended by many, notably the German authorities, but as the result of rather extensive experience with a great number of new school buildings whose rooms were approximately of these dimensions, I feel sure that this is a safe standard, especially for rooms above the first story.

Naturally where the area of glass surface required to light the room will be more than one-sixth of the floor surface, and especially where a ratio of 1 to 4 is needed, windows will have to be placed higher, and hence the ceilings of the class rooms made higher. The decision therefore as to the exact height of a class room ought to depend somewhat on local conditions with reference to the source and quantity of light generally available.

One of the objections which will be urged against making the ceilings of our class rooms  $12\frac{1}{2}$  feet in the clear, is this: It will deprive



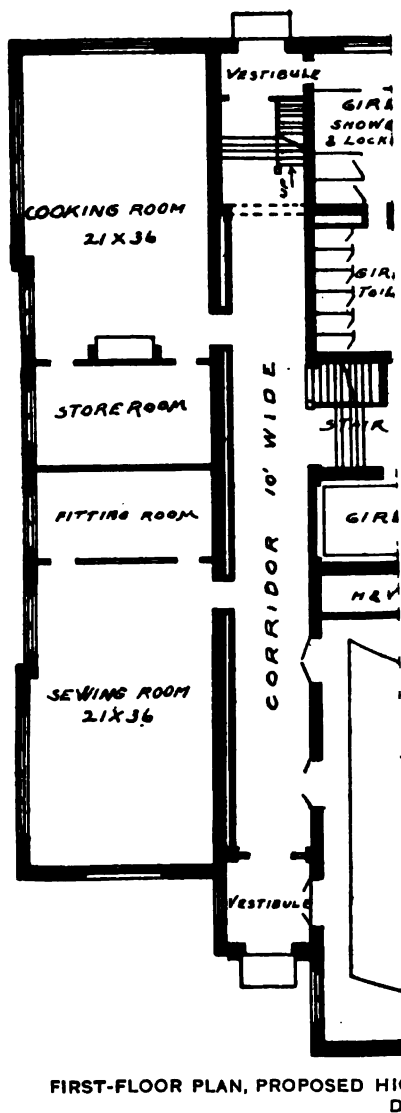
the pupils of air space and hence make the problem of ventilation more difficult. At first thought this objection seems valid; but it is fully answered when it is stated that children need the same amount of fresh air per minute whether they are in a large room or a small one, and consequently after the initial supply is vitiated the same amount must be introduced in either case.

Where any system of forced ventilation is used, the only difference there would be between supplying a room  $12\frac{1}{2}$  feet high, and one a foot higher would grow out of the fact that it would take a fraction of a minute longer for the children to vitiate the air in the room with the higher ceiling, when the fan was not running at sufficient speed to supply an adequate amount. This difference is so small as to be negligible.

In rooms where the ceilings are  $13\frac{1}{2}$  feet high, and where the windows run to within 6 inches of the ceiling, there is a slight advantage if ventilation is to be provided by means of the windows alone. For, since warm air is lighter than cold air, there will be a little more pressure exerted to drive out the warm air where the windows are higher above the floor. This would create a slightly more rapid circulation, especially when outside air is much colder than that demanded in the class room. But this difference in circulation will depend very largely on the management of the windows, and since teachers can not be depended on to keep the windows at all times properly adjusted, this advantage may not be realized in a practical way.

In planning buildings for high-school purposes, the size of classrooms may vary a great deal in order to meet the requirements for different-sized classes. Some subjects attract relatively small classes, and it would be not only uselessly expensive to construct large rooms for such classes but would entail needless expense in maintenance, heating, and ventilation. For example, a class in fourth-year Latin is not likely to be as large as a class in fourth-year English; a first-year class in mathematics will likely demand a larger room than a first year class in German, and so on. There are no figures at hand that are sufficiently accurate and general upon which any helpful estimate can be made with reference to the sizes of rooms needed even for schools designed to accommodate the same numbers of high-school pupils. But the classes in high schools ought not to be large, especially in languages and mathematics. In literature and history more can be accommodated than in other subjects; but even in these subjects good work is impossible when the number of students reaches 30. In those subjects where individual daily drill is needed, the number ought not to exceed 20.

By reference to the floor plans of the high school for Columbia, Mo. (Plates 14, 15, and 16), it will be seen that Mr. Ittner has in-



FIRST-FLOOR PLAN, PROPOSED HIGH SCHOOL

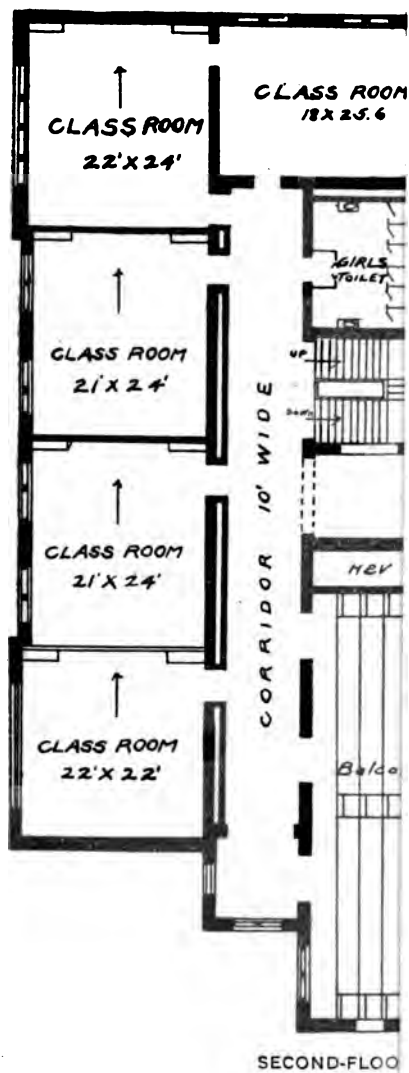
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troduced quite a variety in the size of the class rooms; but the prevailing dimensions for regular recitation rooms are 21 or 22 by 24 feet.<sup>a</sup> The floor plans from Architects Cooper and Baily show the prevailing dimensions of class rooms of the Malden, Mass., high school to be 26 by 32 feet. (Figures 3 and 4.) This latter building was designed to accommodate 1,200 pupils. By reference to a number of the other floor plans for high schools reproduced, it will be seen that great variety in size of class rooms prevails. Generally speaking, however, buildings designed for not more than 300 or 400 students show less variety in this regard than those designed for larger numbers. This could have been anticipated on the basis of practical demands. Elective courses, and increasing emphasis on sciences, English literature, modern languages, and commercial branches have broken up all first, second, and especially third and fourth year classes into smaller groups than was formerly the case. Here again, then, architects and school boards must consult teachers and study curricula and class registrations in order to plan conveniently and economically. The class rooms and recitation rooms of high schools can not be standardized in regard to amount of floor space as can those for elementary schools.

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### SPECIAL ROOMS.

As soon as one begins to make plans for a building for a high school, certain definite and peculiar demands stare him in the face. He sees at once that every high-school building ought, in addition to ordinary classrooms, to contain laboratories for the sciences, rooms for manual training, drawing and art, library, offices, and especially an assembly room. If he is more ambitious he would like to include in the basement, or some more convenient place, a room for cooking and serving luncheons, bathrooms, and a gymnasium.

It is a fact that these latter demands are growing ones, and that in the near future they will take their places as rightful and helpful agencies in every well-equipped high school, not to mention the grammar schools. At present, however, not every community can supply all of these, and it becomes necessary to offer some plans which will include only the bare necessities, while others will be offered for those communities able and willing to meet all legitimate needs. It will be in order then in this connection to set forth the requirements of a high-school building with reference to these special rooms.

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<sup>a</sup> For detailed description of this building, see Appendix B, page 119.



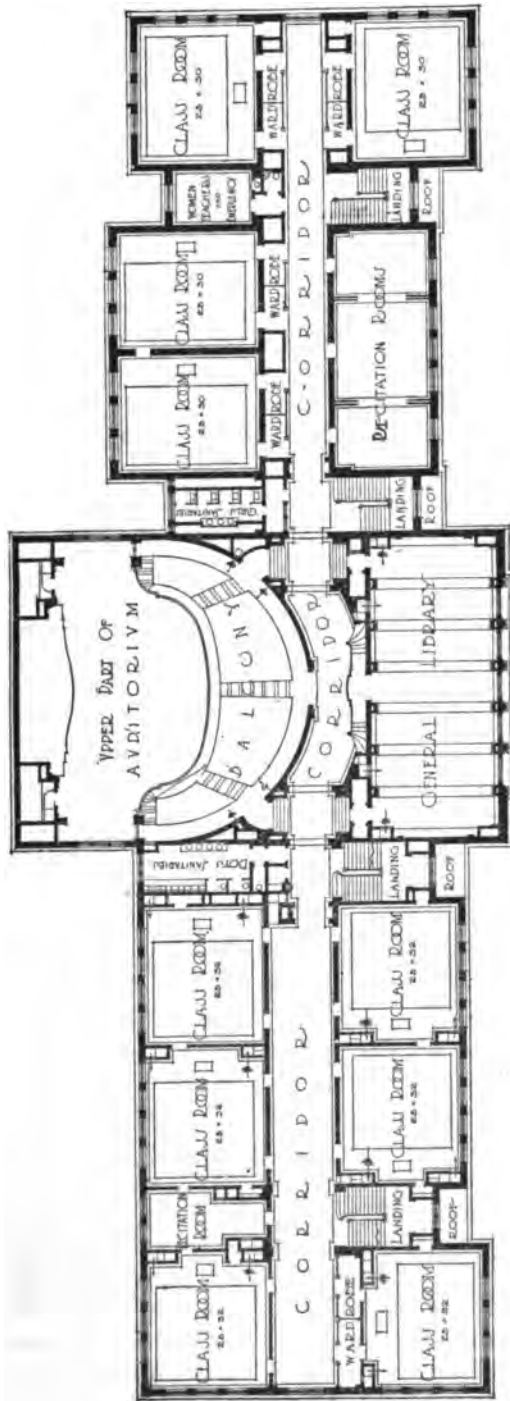


FIG. 4.—Malden (Mass.) High School. Second-floor plan.



## PHYSICAL AND CHEMICAL LABORATORIES.

The time has passed, in the history of education, when it was thought sufficient in a course in physics or chemistry for the teacher to set lessons in textbooks and do the experimenting himself in the presence of the class. There is yet definite need for textbooks, but we have learned that unless the pupils take hold of apparatus and, under specific direction and wise guidance, perform experiments themselves, we can not hope for any lasting interest or thorough understanding of these subjects.

It becomes necessary, therefore, to plan to give each student studying either or both of these sciences room and opportunity for individual work. Furthermore, as a laboratory equipped with tables, gas pipes, water basins, microscopes, balances, etc., can not be used conveniently as a lecture room, where the class may meet to see experiments of a special sort, to discuss them and to compare their own results with certain principles enunciated in the textbooks, a science lecture room is almost a necessity. Hence, at least, five rooms are needed for these two sciences; a laboratory for physics, one for chemistry, a common lecture room, and two smaller rooms for storing apparatus and chemicals until needed. In a high school where one teacher is expected to teach both of these sciences one supply or apparatus room of ample dimensions and of proper construction can be made to suffice. This is true only on the condition that some isolated part of it be set apart for those chemicals which might, by their presence in the same room, be deleterious to certain pieces of physical apparatus. But it is always better to have a separate room for the chemicals, where they may be carefully and systematically placed and rendered less dangerous to both apparatus and the building as a whole.

Suppose two supply or apparatus rooms can be provided, how shall these, the laboratories, and the lecture room be best arranged with reference to each other? In the first place, the question must be asked: Where shall these rooms be placed, on the first floor or on the second, if a two-story building is planned? There are advantages and disadvantages with either location. When a chemical laboratory is placed on the first floor there is danger that the fumes and odors from the chemicals used in experiments may escape into hallways and adjoining rooms, rendering it difficult to keep the air fresh and pure. Then, too, it is better, as far as possible, to use the space on the first floor for recitation rooms, and in this way make it necessary as little as possible for most of the students to climb the stairs often, for it must be remembered that at least three-fourths of the recitations of a high-school course are held in ordinary classrooms. In the next place, it is far more difficult to properly ventilate a chemical



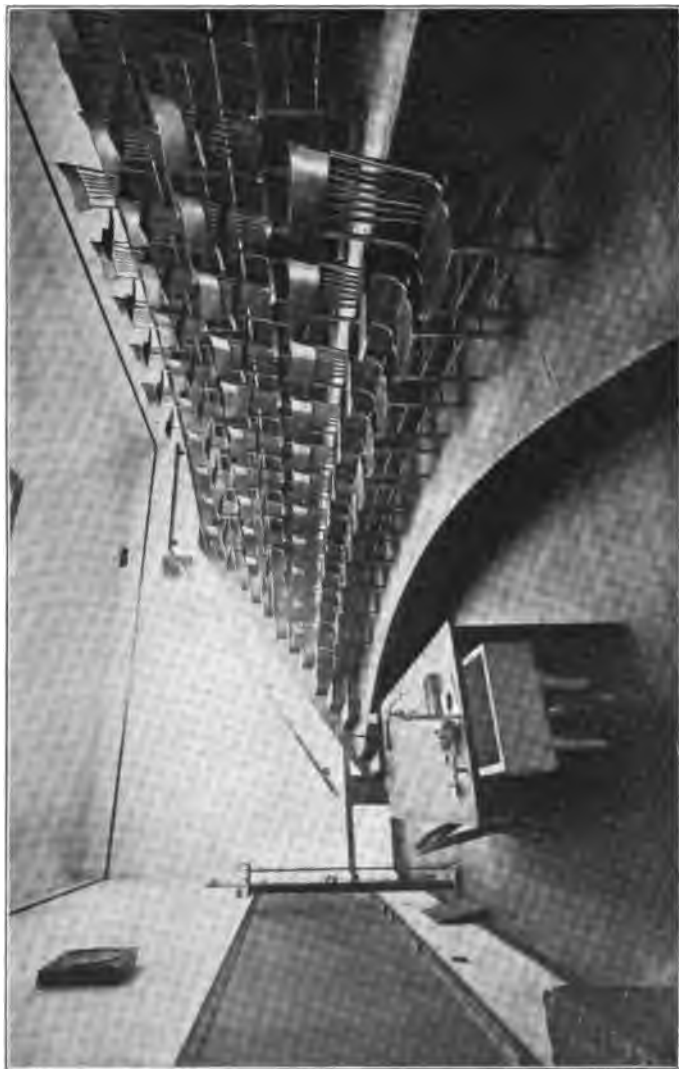
DRAWING ROOM, CENTRAL HIGH SCHOOL, ST. LOUIS, MO. NOTE THE FURNITURE, ESPECIALLY THE TABLES AND CASES. THE LIGHTING IS EXCELLENT.



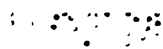
A. COOKING ROOM IN THE FIFTH STORY OF A NEW YORK CITY SCHOOL.



B. FREEHAND DRAWING ROOM, STUYVESANT HIGH SCHOOL, NEW YORK CITY.  
NOTE THE POSITION AND NUMBER OF LIGHTS FOR NIGHT WORK.



PHYSICAL LECTURE ROOM, MADISON (WIS.) HIGH SCHOOL. AN EXAMPLE OF SKY-LIGHTING.



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laboratory on the ground floor than it is on the second floor, which I take for granted is next the roof, for I am convinced that no school-house should be built higher than two stories; all those going beyond this limit introduce many difficulties and dangers merely for the sake of economy. No chemical laboratory can be safely used unless adequate precaution is taken to carry off the fumes and gases generated during experimental work. And these ventilators must extend to the outer air above the building. When the laboratory is on the ground floor these ventilators have to be placed in the walls, and this either makes it necessary to do the work close to the walls or to make sharp angles in the ventilating ducts so that they can overhang the experiment tables in the center of the room. If the ventilating ducts are placed in the walls and the experimental tables arranged next to the walls, it is almost impossible to arrange sufficient work room with satisfactory light without undue expense. If these ducts are bent or elbowed so as to open above the central parts of the room, where the tables should be placed, they are thereby rendered far less effective on account of the great retardation of the movement of the air due to the friction in the crooked and longer ducts. On the other hand, it is much easier and less expensive to supply proper and safe plumbing for a chemical laboratory situated on the ground floor. Gas pipes and water pipes can be easily carried into the walls to the second floor and be brought through the floor at the proper places, but it is more difficult to place the waste pipes and render them safe and hygienic. But aside from these difficulties of plumbing (and they can be readily overcome) and the greater instability of the upper story of a building, there is no reason why the second floor should not be preferred for the physical laboratory. The light is usually better, and the opportunity for many disturbances is reduced. In delicate experiments where jarring or shaking movements are troublesome and disturbing there is a real difficulty. But, generally speaking, there is little or no real need for such experiments in a high-school course in physics, and, judging by the growing tendency to eliminate them, they will shortly be left to the college course, where they belong.

All things considered, I am persuaded that physical and chemical laboratories are better placed on the second or top floor than on the first. Doubtless this will not hold good for all conditions, but in the majority of cases it has proved wise to arrange them in this way.

If it were possible to have a separate building of one story devoted to the sciences, then, of course, what has been said would not apply. It would be an ideal arrangement, as far as laboratories go, to separate them from the main building; but usually on account of lack of space and because of the increased cost of such rooms, they are made to occupy a part of the main structure. This arrangement reduces

the expense of heating, ventilation, and plumbing, as well as initial cost in the room provided.

So far it has been assumed that it is best to have the physical and chemical laboratories on the same floor, and if possible in the same part of the building in order to make the lecture room serve for both, and not to be far removed from the apparatus or supply rooms. The following cut will illustrate what seems to be one of the best arrangements thus far worked out:

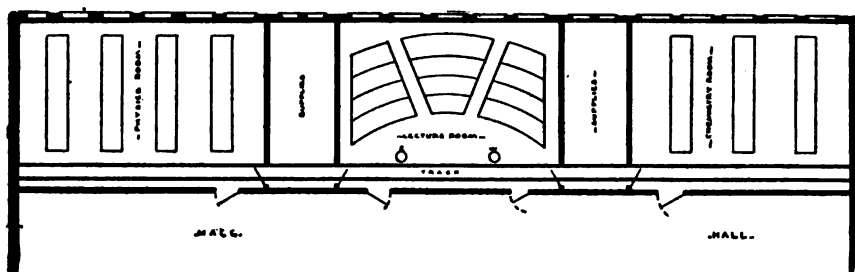


FIG. 5.—A plan for chemical and physical laboratories.

This shows these laboratories occupying the same wing of a building with windows looking toward the east. They are supposed to be on the top floor, and are adjusted with reference to the apparatus rooms and a common lecture room. It will be understood that the lecture room can be built with an inclined floor sloping away from the window side down to the teacher's table. This plan is somewhat objectionable on account of the necessity of the teacher facing the light, and also on account of the pupils having to write somewhat in their own shadows, i. e., with the light behind them, but it insures good light on the apparatus toward which both pupils' and teacher's eyes will in the main be directed. The students will have comparatively little writing to do in this room, for in proper work, the time will be in the main given to observation and discussion, and what writing they will have to do will be limited to a few notes and drawings.

As to the teacher's position toward the light, it may be said that his table can be adjusted on the track designated, so as to give him a position to one side of the front of the room and in this way relieve him from the necessity of facing the light directly. Then, too, if he wishes to spend a greater part or all of the hour in lecturing he can stand to one side still further.

But most of the disadvantages resulting from this method of lighting can be readily obviated by introducing skylight into the lecture room, and this method seems to be growing in popularity since heavy wired and ribbed glass have been manufactured. Skylight is direct and does not disturb either the lecturer or students, and at the same

time offers the least difficulty with shadows. However, it is somewhat more difficult to darken the room for lantern work, and it also introduces difficulties in obtaining proper architectural effects and efficient ventilation where mechanical means of ventilation are not provided. But these objections can be overcome, and skylighting for a science lecture room seems on the whole to be the best.

The track mentioned above and indicated in the cut is of light rails laid flush with the floor so that the teacher's tables, properly equipped with wheels, can be run from the apparatus rooms into the lecture room with the apparatus all in place, and at the close of the lecture can be run back into the apparatus rooms to discharge the apparatus not further needed. This arrangement will save a great deal of the teacher's time and make it possible for the room to be used immediately for another lecture or for any other purpose. It will enable the teacher to prepare for an experiment the day before without appropriating the lecture room. It will save not a little breakage, insure better order in the supply rooms and better care of the apparatus, because the pieces used can be taken from the table and placed directly where they belong or, vice versa, they can be lifted from their places directly to the table.

This arrangement of science rooms is an adaptation of one I saw in the Reform Gymnasium in Berlin and which was recommended highly by the science master.

It will be noticed that the track extends entirely through this whole series of rooms and can be utilized for collecting and replacing apparatus in the laboratories and transporting them to and from the storerooms. This, again, will save much time, especially in supplying the demands of the workers in the physical laboratory. If the track is laid flush with the floor and the side grooves made only deep enough and wide enough to admit the flanges of the wheels, the rails will not interfere with the use of that part of the room and will be in no way objectionable.

But if for given reasons it seems best not to extend the track through the laboratories, it can, of course, stop at the outer doors of the supply rooms and be used only for carrying apparatus to or from the lecture room. It seems wise, however, to lay it in the physical laboratory, on account of the frequent changes in the apparatus needed in a course of experimental physics.

A window from each supply room to its corresponding laboratory has been indicated to further aid the teacher in distributing apparatus and materials to the laboratories. The shelving and cases in these rooms can be arranged to suit the equipment, and ought to be specified by the science teacher or the principal of the school. It is better that no doors should open into the halls from these supply rooms. This will aid in safeguarding the apparatus from meddlers and pre-



vent the entrance of much dust. If sliding doors could always be relied on, it would be better to use this form of door between the lecture room, supply rooms, and laboratories, but since they are usually troublesome, wide swinging doors are indicated, to be set to open away from the apparatus.

In the lecture room there should be a switchboard and water connections, as indicated in the figure by "W" and "E." These could be placed next to the wall or in the wall were it not for the fact that when connected up with the apparatus on the table the wires or water connections would be in the way of the teacher while at work at the table. It seems best, therefore, to make a permanent basin with all necessary plumbing at one end of the table when it is in place and a switchboard at the other end. These, as shown in the cut, ought to be in front and just clear of the edge of the table when moved along the track. These permanent fixtures can be boxed in and made to be covered so as not to present any danger or untidy appearance when the room is used for lectures in any other subjects. In fact, they can be easily finished so as to be transformed into stands from which a lecturer may read, or upon which books can safely rest. With this arrangement they will be out of the way when not needed and ready for immediate use when required.

The wall space between the doors into the hall can be used for a blackboard. It is best to set it 4 feet above the floor and make it at least  $3\frac{1}{2}$  feet wide. It should be of slate, glass, hyloplate, or cement of a good grade and set as near flush with the wall surface as possible, in order that a white curtain may be pulled down from a roller fastened against the wall close to the ceiling. The purpose of this curtain is to furnish a surface upon which lantern projections may be thrown. The stereopticon or projectiscope can be used to advantage not only in the sciences, but in history, literature, and art. To this end a small, level platform ought to be constructed near the side of the room next the windows, from which lanterns or like apparatus can be used. This suggests proper electric wiring for light and provision for thoroughly darkening the room. And just here let it be said that a little forethought and definite planning will save time and often much trouble. For example, instead of depending on a loose wire down the hallway to the teacher's table, a signal wire can be run under the floor and emerge at the right places with practically no expense. This will always be ready and save much annoyance. The seats in this room should be of the opera type, with two aisles in the central part and one on each side. There should be two doors opening from this room into the hall, as indicated. This will prevent crowding, save time, and make it possible for the room to be used for other classes even while the laboratories are in use.



**A. CHEMICAL LABORATORY, QUEEN ANNE HIGH SCHOOL, SEATTLE, WASH.**



**B. PHYSICAL LABORATORY, QUEEN ANNE HIGH SCHOOL, SEATTLE, WASH.**

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If the windows, in case lateral lighting is used, are placed 4 feet above the main-floor level, the rear of the inclined floor will not seriously obstruct the light, for 3 feet rise will be ample to insure to each student a chance for unobstructed observation. It is needless to say that the location of the electric or other lights, permitting the use of the room at night, is a matter of importance, but must be left to the architect and the principal to work out.

*Floors.*—The laboratory floors, especially on the chemistry side, are matters of rather serious concern. Cement is heavy, expensive, and both hard and cold. But it is cleaner and safer than wood. It can be scrubbed without harm and can be replaced without serious disturbance when worn. Perhaps the best floor that can be constructed for a chemical laboratory is that made by laying hard-baked glazed tiles in cement. These tiles when of good quality are nonporous, nonabsorbent, acid proof, and are easily cleaned. They are durable, and when planned with due respect to artistic effect give to the laboratory a clean, neat, and wholesome appearance. A laboratory in which this material is used for the floor is rendered still more artistic and aseptic by using the same material for wainscoting. This material is rather expensive when considering the initial cost, and consequently will be used sparingly save in fireproof construction and in those wealthier communities which can afford the best. In the long run such a floor is economical, for it is easily cleaned and lasts indefinitely when properly set.

Another form of floor covering consisting of cement and broken bits of marble mixed evenly and then polished to a level surface has been used, but this is subject to injury by acids, and is both hard and cold. Some builders have used a good quality of cement, and with due precaution such floors have proved fairly satisfactory. They are, however, porous, will in time stain and discolor, and will also suffer from acids.

When any of the fireproof floors are used it is well to surround the work tables with some form of linoleum to protect the feet of the students from the cold floor and to lessen the fatigue incident to long standing on a hard surface.

If wooden floors are used in a chemical laboratory, they should be protected by wax, paraffin, or some such material. Wherever finances will permit, and especially in a brick, stone, or concrete building, the use of tile floors is strongly recommended.

Floors made of asphaltum are recommended by Professor Gill. "But," as he remarks, "there is danger that heavy tables, chairs, etc., will sink into the asphaltum and thus render them of unstable balance and out of level." This, he suggests, may be partly overcome by making wide foot rests for such tables. Naturally, this sort of floor

must be laid on the top of a close-fitting underfloor and separated from it by tarred paper, asbestos board, or some form of steel lath. In every case where a laboratory is on the second floor all possible leakage from water pipes or basins must be prevented, and this is best done by taking care in construction.

Doctor Baskerville, of the College of the City of New York (Science n. s. 28, p. 665 f.), says:

In my opinion, the best material for floors which has been put forward is that which is known as lithoplast, devised by Dr. W. L. Dudley, of Vanderbilt University. It is essentially a paraffined sawdust-sand floor, with a magnesia cement. This flooring may be laid in any length and in one piece and offers many desirable qualities. The baseboard may be made as a part of this floor. There are no cracks. The presence of the sawdust allows of its expansion and contraction with changes of temperature and the coating of paraffin over it prevents its rotting or napping, which are objections put forward in opposition to sawdust. It may be tinted, polished, washed, or scrubbed. It can be repaired without having cracked joints, and, furthermore, it allows nails and screws to be driven into it in much the same way as wood does.

When it comes to a consideration of the material to be used for the tops of the laboratory tables, a more difficult problem must be confronted. It is without doubt true that all, or nearly all, of the older tables used for this purpose had wooden tops, and as a result of habit in the making of other tables oak or some more expensive material was used and finished with much care for appearance's sake. But, as all who have worked in a chemical laboratory know, it is only a matter of weeks until such tables are blistered, stained, or discolored until they are unsightly, and it seems unnecessary to use expensive lumber and go to the trouble of polishing and varnishing it, as is done with furniture in general. Good, clear pine, free from pitch, is about as serviceable as oak. Naturally, there is some danger in the use of wood, but it causes less breakage of test tubes and beakers than almost any other material used. It is not so cold as glass, tile, or slate, and hence does not endanger glass apparatus as much.

Theoretically, plate glass is the most satisfactory material for table tops, for it does not stain, is easily kept clean, is nonabsorbent, is not affected by acids in ordinary use, and from the standpoint of wear is durable. The only objections of serious importance that can be offered against the use of glass for this purpose are that it is cold and hard and is liable to crack from the heat reflected from the bottom of vessels heated during experimental work. This latter is such a serious objection that it seems wise to caution against its use. It has been in use in the laboratory of the San Diego High School, but the teacher of chemistry there says he would prefer wood properly treated.

In the high school at Seattle, "opaline tiling" has been used for eight years and has proved to be easily cleaned and attractive, but is

beginning to crack and chip and will have to be replaced in a few years. Mr. Muller, the teacher of chemistry in this school, writes me that he would prefer wood properly treated.

Mr. Fischer, teacher of chemistry of the McKinley High School of St. Louis, says that his table tops are made of "artificial stone," and that he has found no objection to this and prefers it to any other material. This is one of the best high-school buildings in the country and this opinion of its teacher of chemistry ought to and will carry much weight.

Professor Gill says:

For the tops of laboratory desks or tables the following woods have been found to give good satisfaction: Northern pine, whitewood, cedar, and California redwood. These may be finished with equal parts of linseed oil and turpentine, or better, filled with aniline black made in the pores of the wood.

It may be added here that sugar pine is an ideal wood for table tops for laboratories, for this wood does not readily warp, can be had in boards wide enough for a full top, and so will leave no cracks, it does not splinter, can be planed easily, readily takes the stain and filling noted above, and is not heavy. Unfortunately, the great trees from which such lumber is made are rapidly disappearing, and therefore the lumber is comparatively expensive.

Mr. Lincoln of the Technical High School of Springfield, Mass., writes me that he prefers wood as material for table tops for beginners in chemistry on account of the danger of increased breakage with the use of harder surfaces, but personally prefers white glazed tiles if they can be laid so that they will not buckle. When wood is used, he prefers soft pine treated in the following way, which is the same as that recommended by Professor Gill:

*Receipt for treating tops of laboratory tables.*

**Solution 1:**

100 grains aniline hydrochloride,  
40 grains ammonium chloride,  
650 grains water.

**Solution 2:**

100 grains copper sulphate,  
50 grains potassium chlorate,  
615 grains water.

Apply solution 1, let it dry, then apply solution 2 and let it dry. Do this three times.

During this process the color changes from green to black. The table top is then washed with hot soap solution, allowed to dry, then rubbed down with vaseline. After this last the color of the table top is a soft deep black.

The tables treated as above have given very good service. They are wiped with a damp cloth each day after the laboratory work is over.

**Walls.**—In a chemical laboratory it is important that the walls be so constructed that the material composing them will not discolor or

disintegrate as a result of the acids liberated in experimental work. The ordinary plastered walls are very unsatisfactory, for this disintegration begins quickly, and not only litters the floor but causes the room to appear untidy as a result of the rough and stringy appearance of the plaster. In laboratories where any quantitative work is done this falling material will vitiate results and cause much trouble. In sections of the country where earthquakes occur the plastering so affected is likely to fall and is therefore dangerous. The same is true in the event of fire. The use of cement instead of ordinary plaster is followed by similar troubles.

As I have already said, hard-glazed tiles are clean, durable, neat, and acid proof, and when carefully selected and well set are easily cleaned and are also attractive in appearance. Glazed white brick is still more to be desired, but is expensive, and for inner walls adds considerably to the strength necessary in the building. Unglazed bricks may be used, but need to be covered with an acid-proof white or cream colored paint. Prof. Gill recommends for such purpose a paint made of "sublimed lead ( $\text{PbSO}_4$ ), barytes, or zinc white, or preferably a mixture of these in about equal proportions."

On the whole, despite the added danger due to the inflammable material, a ceiling made of well-seasoned pine or maple, carefully tongued and grooved with the boards not more than three inches wide, blind nailed and then treated with acid-proof paint, seems best adapted to a chemical laboratory for high schools. This is, in its initial cost, more expensive than plaster, but in the end it is cheaper and much more satisfactory.

Where plaster must be used "white plaster, which has been given three coats of acid sulphur-proof paint, a combination of lithophome and zinc oxide, has proved satisfactory. All metal ware which is likely to be exposed to any fumes whatever in the laboratory should be painted with an acid-proof paint."

In the plan presented to indicate the proper arrangement of the science rooms, it will be noticed that the main aisle is along the wall away from the windows, and along the track laid in the floor. The tables in the laboratories ought to be placed at right angles to the main aisle, with individual work spaces and plumbing on each side. This will insure good light and better classification of the workers. The secondary aisles between tables can be made as wide as space will permit; but they should be at least 5 feet.

Further discussion of the arrangement of science rooms seems unnecessary, for equipment and plumbing are matters which school authorities must settle for each individual case. This further point, however, ought to be emphasized: It is a serious menace to the health of the students to work in a chemical laboratory which is not provided with adequate means for carrying off the fumes and keeping the air

pure and clean. Therefore, directly above the tables upon which the experiments are performed ducts should be placed to carry off the gases liberated in the experimental work. In small laboratories gas jets kept burning within the main part of the duct will create a fairly good draft and in this way help to keep the air pure. But in a larger room where many students are engaged and the system of ducts rather complicated, it is best to place in the pipe between the roof and the ceiling a small exhaust fan with an electric motor attachment to be run during the laboratory periods. This fan must be firmly bedded so as not to jar or buzz while running, and the branching ducts must be as free as possible from sharp angles, and air tight between the openings above the tables and the outer air above the roof.

#### ASSEMBLY ROOMS.

The assembly room, or aula, as it is called, is the center of school life for a German gymnasium. It is the place of all places in the school where artistic and even lavish decoration is the rule. It is the historic remnant of the days when churches and chapels were used as gathering places for students, and it has retained some of the religious atmosphere of those bygone days. They gather here for music, for worship, for lectures, for counsel, or for some celebration. Stained glass windows, beautiful mural paintings, tasteful pieces of statuary, and very frequently a pipe organ attest the fact that this room is designed to be used for important educational purposes.

I shall never forget the pride exhibited by the director of the new gymnasium in Wittenberg, that quaint old Saxon town where the mighty Luther and the scholarly Melanchthon wrought, when he took a small party of Luther enthusiasts to the aula. There in the rich subdued light, streaming through beautiful stained windows, he showed us a magnificent mural painting of Luther before the Diet at Worms. It was a piece of real art, painted by one of the best artists of modern Germany. It represented this historic scene, the most dramatic of Luther's career, in a striking way, and this would of necessity teach a lesson in courage for convictions as no other feature of the school could teach. It was by far the best room in the building, and was built, kept, and used for the social, religious, and artistic unification of the life of those German lads who were fortunate enough to attend this school. But such an aula, thus inadequately described, is not the exception but the rule in the higher schools of Germany. The Germans understand the social, ethical, and artistic demands of youth, and strive to meet their needs in part through the use of music, lectures, celebrations, and assemblies of one kind or another.



We are making rapid progress in supplying assembly rooms for both high schools and grammar schools, as will be seen by reference to the floor plans later presented. The illustrations herewith presented should arouse our pride, for they are as beautiful and commodious as many of our best theaters. But for our smaller and medium sized high schools, we are not yet demanding what we should in this regard. It is earnestly hoped that the illustrations here reproduced will serve to stimulate to further efforts to secure for all schools this much needed and very helpful agency.

There is no desire to overestimate the need of assembly rooms in the American public high school, but I believe there is no country in the world where the need of social unification, artistic refinement, and cooperation is more pressing than in our country, under our form of government. Loyalty to athletic prowess is a good thing, but there is need for a deeper, more fundamental loyalty to school, to scholarly ideals, and to the community; and an artistic assembly room will greatly contribute to these ends. Every high-school building, then, ought to be built to meet this need. In addition to the uses above suggested, it will be a great stimulus to boys and girls in the grades if they also can occasionally share in the use of these rooms. I believe wise supervision of city schools demands closer contact between the children of the grades, especially the upper grades, and those of the high school. It would be a powerful stimulus to many boys to endeavor to enter the high school if now and then they could get a peep into the laboratories and assembly rooms of which they sometimes hear but which they rarely or never see. Moreover, around the school, as has been suggested, are gathering many organizations for social service looking to immediate help in practical citizenship. An assembly room, properly and tenaciously guarded against those who have selfish ends to serve, can become the rallying point for the general educational movements in the community. Such use of a school building will not desecrate it, and can, if wisely directed, be of great service in connecting school work with the real and vital problems of the community.

Having said so much in general, and these arguments are often needed to convince those in authority of the importance of supplying an assembly room, let us now turn to the actual demands of construction.

The first question to consider is its location in the building. The prevailing practice in the older buildings was to put it on the second floor, but this I believe is passing away, for surely the first floor is a better place. This location saves much wear on the building, in that it enables large audiences to gather without threading hallways or climbing stairs. It makes it easier to start the day's work with an assembly, and in this way gives opportunities for announcements by



**A. NEW GYMNASIUM, WITTENBERG, GERMANY.**



**B. A HIGH SCHOOL ASSEMBLY ROOM, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT.**



**A. ASSEMBLY ROOM, DE WITT CLINTON HIGH SCHOOL, NEW YORK CITY.  
C. B. J. SNYDER, ARCHITECT.**



**B. AUDITORIUM, STUYVESANT HIGH SCHOOL, NEW YORK CITY. C. B. J. SNYDER,  
ARCHITECT.**

the principal, for the inspiration of song, readings, or short addresses. It is safer in case of fire, permits of easy entrance from the second floor to the gallery, allows ample height for the stage and for the ceiling above the gallery without interfering with a uniform scheme for roofing. It insures a safer and stronger building for large audiences, and gives a better opportunity to properly heat and ventilate it. By thus using the height of two stories, the floor of the main room as well as that of the gallery can be inclined without interfering with any other part of the structure, and extra exits can be arranged with little expense, and without marring the architectural effect of the building as a whole. This position will also have the advantage of the wider hallways and exits below and will thus avoid crowding in the halls and on the stairways. If situated in the central axis of the building, and opposite the main entrance, it will give a unity and dignity to the interior, not possible when on the second floor. The floor plans and cuts herewith presented illustrate the arrangement of the assembly room for a large building and also for a smaller building.

Such a room must be provided with a stage of ample proportions. Upon this stage the young people will gather on graduation day to receive their diplomas; from it they will give their plays, choruses, and recitals; from it they can hear lectures and concerts by visiting talent; and in many ways there will be need for a roomy and safely built stage. There should be dressing or retiring rooms at both ends of the stage and on the same level with it.

All assembly rooms call for ample light, and the stage should have windows, but placed so high that they can not be seen by the audience. In large schools, there should be a gallery so constructed as to require as few supports from the main floor as possible, and built with due care for the demands of acoustics. The lighting of an assembly hall is an important feature in its usefulness and should be given careful consideration. If, as has been suggested, this room is placed on the central axis of the building and on the ground floor, light can be had from both sides, above and below the gallery.

In village and country high schools there is as much or more need, comparatively speaking, for assembly halls as in cities with more pretentious buildings, and yet under the stress of financial conditions they are often eliminated from the plans for the smaller schools. The accompanying floor plans for a small building (fig. 6) were drawn with this difficulty in mind, and the hallway has been widened so as to serve both for a passageway and an assembly room. It will be observed that the hall is shorter than the wings of the building and ends in a raised platform or stage, which can be cut off by folding or sliding doors and used as a library, principal's office, and a stage. An open fire in the center will make it attractive from

within the office, and also from the assembly hall. It will be noticed that cloakrooms are connected with each room so as to keep the hall clear. Movable chairs can be used and quickly arranged when needed and crowded together when a wider passageway is needed along the sides or across the hall to facilitate the movement of the students between recitations. Provision can easily be made in the event that this room is needed for a study room. The ceiling of the assembly room is high, is finished to show the timbers, and is lighted from above. I am indebted to Mr. Bernard Maybeck, architect, Berkeley, Cal., for the drawings. This building can be built of wood, plastered on the outside or shingled, or of brick or stone. It does not readily lend itself to a painted clapboard construction. It should be made

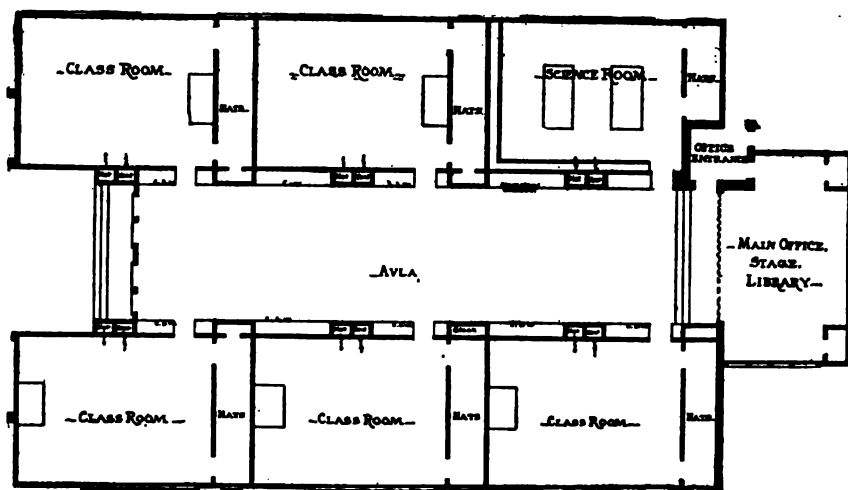


FIG. 6.—Plan for a village high school, so arranged that the hall may serve as an assembly room, with the main office as the stage.

to blend with the landscape, and when covered with vines will make a charming village high school for the accommodation of 75 to 100 students.

### FLOORS OF SCHOOL BUILDINGS.

That part of the schoolroom which receives the roughest usage is the floor, and when laid improperly and of poor material is both insanitary and very difficult to keep in order. Perhaps there is no part of a school building which has so much to do with the general sanitation and neatness of halls and class rooms as the floors, and surely no part requires so much attention. It is a great mistake to be niggardly in expense when it comes to the material for floors, for in the end good floors are much less expensive, when considered merely from the point of view of length of service, than are poor

ones; but good floors are also less expensive to keep in order and will save much janitor service.

It is proper, then, to ask, What are good for school buildings? and how are they constructed?

In the first place there should be, in those buildings not fireproofed, double floors in all schoolrooms, especially in those situated in the first story. This is important for several reasons, but chiefly to prevent the inflow of ground air and bad odors from basements. (See the section on the Location of a Schoolhouse.) The first or under set of boards should be rather narrow and well seasoned, but may be made of any durable wood and left rough, though of even thickness. They should be laid diagonally with the joists and made to fit closely. Over these should be carefully fitted some covering both impervious to the air and deadening to sound. If no material can be obtained combining these two qualities, then air-proof paper and deadening material should both be used. Tarred paper is effective in keeping out the ground air, but its use is questionable on account of its inflammability. A good quality of asbestos paper or felt will serve the purpose of deadening and at the same time present a fairly good barrier to the entrance of ground air. It is more expensive than many other forms of deadening material used, but it has the advantage of being noninflammable. In small buildings, however, especially for country and village schools, it is far better to use heavy building paper than to use nothing at all. Whatever form of deadening material is used, builders ought to use it carefully, so as to keep the floor level and stop all the cracks from below.

Double floors soon save their cost, especially in cold climates and where fuel is high. I know of no figures expressing the exact proportion of this advantage of double floors over single floors, but a moment's thought will suffice to see a distinct saving.

From the hygienic point of view single floors on the first story of a school building ought not to be tolerated, for during the winter season—and this is almost always the school season—the children will suffer constantly from cold feet. Such a condition is not only annoying and distracting to teachers and children alike, but fruitful of colds and bronchial troubles through the effects of impeded and uneven circulation.

I have emphasized the need of tight, air-proof floors for the first story of a school building because of the danger of cold floors and the entrance of bad odors and noxious ground air. In the upper story the matter of noise is especially troublesome unless the floors are thoroughly deadened and made so secure as to prevent jarring. The problem of deadening the stairways, the floors of the halls, and rooms of the upper story is therefore a more insistent one than it is for the lower rooms.

In buildings thoroughly fireproofed the problem is rather easily solved, but in buildings where wooden joists and steel laths for plastering are used it is a much more difficult task. There are on the market a great many patent deadening felts, or quilts designed for this purpose. Some increase the fire risk; others if free from this fault are not so made as to break up most effectively the sound waves and prevent their transmission to the ceiling below.

The method of deadening shown in figure 7 was designed to meet the requirements when the deadening quilt is used. This material is made of "cured eel grass" arranged in crisscross layers and then spread between two layers of paper which are stitched or quilted together. My experience with it warrants me in saying that it is effective as a sound deadener when properly laid. It can be used effectively on inner walls, as well as on the floors. It is somewhat expensive, costing about half as much as plastering. Perhaps the safest of all deadening material is asbestos board, or quilt, which can be had in most any market; but if this is used for deadening purposes chiefly it must be of good heavy grade and carefully laid.

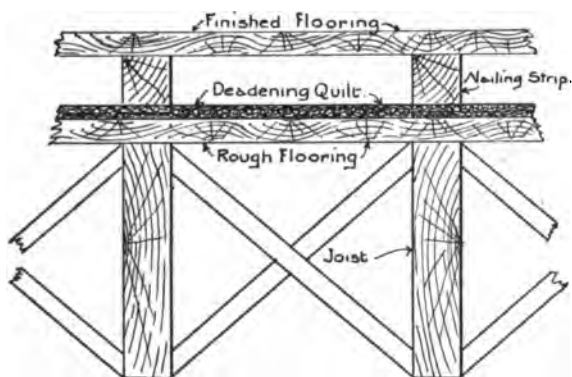


FIG. 7.—Section of floor, showing the use of deadening quilt.

In this discussion it has not been my purpose to give directions to architects, because it is their business to have more extensive knowledge of such things than other people. My purpose is to call the attention of teachers and members of building committees to the need of making careful provision for good floors, and then of rendering them as impervious as possible to the entrance of cold or foul air and proof against the transmission of disturbing noises.

To some, who are used to conditions as they now exist in our best cities, this discussion of the need of double floors may seem out of place, or at least useless; but to all such who read these lines let me say there are hundreds of schoolhouses being built this year in our country with single floors. It is to help to prevent a continuation of this error that the above was written.

In the next place, hard wood should be used for the upper set of boards, and so carefully selected that every board will be straight grained and free from defect of any sort. One or two slash-grained

boards in the floor of a hallway or classroom will inevitably bring trouble. They splinter easily, gather and hold the dirt, take on a different color from the rest of the floor, and cause that untidy "spotty" appearance so disturbing to all who are sensitive to seemingly things wherever found. It is therefore quite important that close supervision should be exercised over builders when they are laying floors. Somebody with authority and good judgment in matters of this sort ought to be in constant attendance to pass upon every board used. It is far less disastrous to use questionable lumber in wainscoting or walls than to use it in the floors. Floors are sometimes rendered unsightly and difficult to keep sanitary when hard pine boards, with streaks of pitch or rosin in them, are allowed to go in; for as these boards season and shrink this material will gradually work out, leaving gashes in the floor hard to keep clean and always unsightly. The best material to use is narrow boards of well-seasoned and carefully selected oak. Such boards wear evenly, do not splinter, are not affected greatly by changes in the weather, are easily finished, and give to the rooms an æsthetic character worth a great deal when considered in relation to management and good taste. But oak lumber of a good grade has become very expensive, and it may not always be possible for school authorities to see their way clear to its use. Perhaps the next best available wood for schoolhouse floors is hard maple, sawn in narrow boards, of straight grain, and free from all defects. This makes a neat floor, takes a good polish if skillfully handled, and wears well if it is kept well oiled or waxed. It is softer than oak, however, and shoe tacks easily dent it. It requires more care than oak floors, and in this respect is not so economical. It can be made to fit together well, and is not readily affected by dampness, though more porous than oak.

Hard pine is generally the most available material, and when carefully selected and prepared makes a good, durable, and beautiful floor. Since this is the material most often used it seems fitting to consider it somewhat carefully. In the first place, the boards ought to be from 2 to 2½ inches wide. If they are wider it will be almost impossible to get them so well seasoned and so carefully joined as to prevent cracks from opening between them. They must have a straight, close grain, be free from pitch gashes, and sufficiently thick to prevent the tongue from splitting the upper edge.

They must be set carefully and fastened (blind nailed) with cut nails. Here again there is constant need of active, vigorous supervision in the laying of schoolroom floors. It is a fact, however doleful it may seem, that American workmen are not as careful when building for public as for private interests. Doubtless there are many exceptions, but experience is on the side of this general asser-



tion. What would otherwise be a good floor may be badly marred and rendered unfit by dents from the hammers of poor workmen when they are blind nailing the boards. Such workmen try to excuse themselves by saying that those dents soon close up. Yes, they do; but it is with dirt. Surely ceaseless vigilance, unquestioned authority, and special knowledge on the part of the supervisor is the price of good floors.

One specification with reference to floors in school buildings is frequently omitted from contracts, but is deserving of more consideration. After floors are laid and all the other work in the room is completed they ought to be planed or sandpapered to an even, smooth surface. Unless this is done it will be impossible to polish them well or to remove the stains incident to building operations.

In buildings of fireproof construction steel beams are used for joists, and usually the space between them is filled with brick and cement, or, better, with specially prepared earthen tiles and cement. A cheaper method consists in suspending a series of bent wires from joist to joist, so they will give strength to the cement, and then boxing up underneath and pouring in sufficient cement to fill the space. When the cement is set it has a firm grip on joists and wire. Then by screwing thin strips of wood on the tops of the joists the floor can

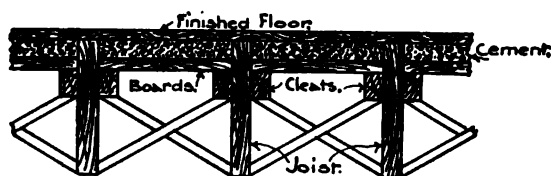


FIG. 8.—Floor with wooden joists and a thin layer of cement.

be easily and securely fastened. Of course it is necessary to fill the space with cement flush with the tops of the strips in order that the floor may rest evenly and closely

against the cement. This will effectively deaden the floors and render them thoroughly sanitary from the underside.

Where wooden joists are used the floors may be deadened with fair success and a complete double floor rendered unnecessary by the method illustrated in figure 8.

This treatment reduces the risk from fire, but is more expensive than double floors with deadening materials and adds materially to the weight of the building. Doubtless many other ways can be devised to deaden the floors more satisfactory to local demands than any here mentioned. My purpose will be attained, however, if the floors are deadened, and more especially, if fireproofed in any acceptable fashion.

In buildings of fireproof construction a single floor is sufficient, for the materials used in fireproofing both deaden the floors and protect them from the cold air from below.

*Platforms.*—There is no need in an ordinary schoolroom for a teacher's platform or rostrum. To many this statement may seem to be nonsense. But stop to think a minute. They are always in the way, they are hard to keep clean, they are rarely in the right place, and even when not fastened to the floor, they are too heavy to move easily. They are a remnant from medieval days, when schools were dominated by the church, when monks were teachers, and when the work of the school consisted in listening to lectures and copying verbatim what was said. Then the teacher spoke *ex cathedra*, i. e., from a pulpit, and pupils accepted without understanding. To-day the teacher, with books and helps of all sorts, merely guides, directs, inspires, and amplifies. In the primary grades more direction and help are needed, but they are given usually at the desk of the pupil or at the blackboard. But the teacher to whom this will seem an invasion will object, saying: "But how could I see my pupils when seated on the same level with them?" The best answer to this, and the only one that will convince, is this: Try it and see. Another will say, "It will take away the teacher's dignity." Well, if dignity is a matter of platform, then it is well to get rid of it. A teacher can not have too much true dignity, but this sort comes from within, and exhibits itself in wisdom, judgment, understanding, and genuine sympathetic help. Platforms and silken robes are for defectives.

A good teacher has no need to spy on children, for the more they can work together the better the result. A neat table or desk and a simple chair is all the pulpit a regular class room needs. Then almost the whole front of the room is free for workers and for such apparatus as the day's work will demand. Of course in science lecture rooms and in assembly rooms platforms and stages are needed. If you have never taught in a room without a platform, you will find much relief, especially in grammar-grade work. Your room will be neater and the space for moving about much less obstructed.

Another elimination from class rooms ought to be urged in this connection, and that is the "carpet strip" beneath the doors. If the floor from the hall is continuous through the door, and the door set to swing just clear of the floor, there is much relief from dirt, stumblings, and noise when nothing obstructs the entrance. It is good school hygiene to eliminate all that is useless both in building and in the program.

After floors are laid and well prepared, they should be treated with wax, dustless oil dressing, or some other durable protecting material. The so-called dustless oil floor dressing has, when used with skill and judgment, proved of great service in protecting floors and preventing the dust and dirt from rising into the air. It is best to put it on sparingly, however, to prevent any possible odors, and

more especially to prevent it from soiling the skirts of the larger girls and women teachers. A great deal of complaint is frequently heard on account of this, and not infrequently such complaint is justifiable, for there is no need to keep the floors saturated with oil to get the best effect. This trouble sometimes results from the use of an oil too thick and heavy, but usually from using it too often or applying too much at one time. Janitors have found that it saves much time in dusting, and are negligent of the comfort of others. When a thin coating of light oil is put on with a brush made for this purpose, and all pellets of dust and dirt collected by this oil are removed from the floors daily, there ought to be little or no complaint from those teachers who value the cleanliness and healthfulness of the schoolroom more than their own convenience or personal preference. Besides, any thoughtful teacher may overcome most of her distresses in this regard by the use of a rug or a bit of linoleum at her table. There is more difficulty in high schools and the upper grammar grades with the use of such floor dressing than in the lower grades. This is due of course to the fact that girls of these grades wear longer skirts, and parents, not understanding the advantages of the use of oil to the school as a whole, bitterly complain when skirts are quickly soiled or ruined. I have known one or two superintendents of schools to be discharged as a result of troubles starting in unintelligent use of dustless oil in schools.

In high schools where pupils are more careful to keep their shoes clean, and especially in those buildings where good hardwood floors are laid, it is best to wax the floors and keep them well polished. This method, of course, does not prevent so much dust from rising, and it requires more service to keep the floors in good condition; but with the use of dampened sawdust to gather up the dust when sweeping, and with due care, a waxed floor is most satisfactory.

There are several kinds of dustless oils on the market, and also many varieties of floor wax.\* No general recommendation is needed, and indeed none could be made which would be found reliable under all conditions, for the different woods used for floors will need different treatment.

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\* Clay recommends a wax polish for hardwood floors made in the following way:

	Parts.
Yellow wax .....	20
Yellow ozocerite .....	20
Linseed oil (boiled) .....	1
Raw sienna .....	5
Turpentine .....	25

Mix the two waxes over a slow fire, add the oil, and when cold add the turpentine. (See *Modern School Buildings*, Felix Clay, London, 1902, p. 288.)

**BLACKBOARDS.**

Nowhere in the world, I believe, are blackboards used so extensively in schools as they are in America. They are essentially democratic and individual in their service, as contrasted with their use in countries where the teacher rules and guides with autocratic authority, and is the source of a large part of the information given to the pupils. A large area of wall space set apart in class rooms for blackboards assumes that pupils will individually present to their fellow classmates and to the teacher the results of their study, so that the free give-and-take of criticism will result in an independent, self-helpful assurance necessary to all good citizenship in our form of government. Blackboards are, then, not merely pedagogical conveniences but civic agencies worthy of consideration.

The history of blackboards is an interesting one, but for obvious reasons it would be irrelevant to recount it here. Suffice it to say, however, that they were used in Europe more than three centuries before they found their way into the schools of America. They were not introduced into our schools until the first or second decade of the last century, and were then merely blackened boards, as the name indicates.

In the planning of school buildings, it is a matter of much importance not only to provide sufficient room for blackboards, but to so place them with reference to the light that they will offer the fewest possible disturbances to vision. If the form of class rooms elsewhere recommended is chosen, the unused appropriate wall space in the back of the room, on the side opposite the windows, and at the teacher's end of the room should be prepared for blackboards. This will give approximately 70 linear feet of wall surface for this use. No blackboards should ever be placed on the same side of the room as the windows, and particularly between windows. To those who can recall the tiresome and painful effects of trying to see any work placed on a blackboard situated between windows, no argument will be needed to prove the wisdom of this prohibition. But there are still some school authorities who permit such a mistake, and to such as these I wish to say merely that when the eye is adjusted to an object reflecting one strength of light, it is out of adjustment for others reflecting either greater or less light. When a blackboard is situated between windows and a pupil at his desk undertakes to read any work written on this board, he must of necessity receive the light of the windows directly in his eyes. Such light being far stronger than that reflected from the written work on the board, his eyes automatically adjust themselves to the strong light, and hence he must either squint or strain the muscles of accommodation to see at all clearly. The evil effects of these eyestrains and malad-

justments are too obvious to need further discussion. So I repeat, *never* should a blackboard be put between the windows in a system of unilateral lighting.

Taking for granted, then, that the proper portions of the walls have been prepared for blackboard, how high above the floor should the lower part of the board be set? Plainly the answer will be this: They should be so placed as to give the children the use of the greatest amount of blackboard room while standing erect, or nearly so. In rooms designed to accommodate pupils of the first and second grades of the elementary schools the bottom of the blackboard should not be more than 25 inches above the floor. For third and fourth grades, it can be set 27 inches; for the fifth and sixth grades, 30 inches; for the seventh and eighth grades, 32 inches. If these figures are followed for setting blackboards in rooms designed for elementary school purposes I am persuaded that they will not be far from the exact height required by the pupils. Of course some very tall pupils in the primary grades or some very short ones higher up may be somewhat troubled. It is necessary for architects to specify clearly these limits, or some closely approximating limits, else builders, when figuring on wainscoting or cutting it, will overlook these matters and set the boards too high for the primary classes. For rooms designed for high-school classes the distance between the floor and the blackboard should be not less than 3 feet. In rooms designed especially for classes in languages or literature they can be put 2 inches higher with good effect, for while a student can make fairly good figures lower than this, he can not write well below this level. At the teacher's end of the room it is best to raise the blackboard at least 42 inches above the floor, for this board will be used chiefly by the teacher to indicate lessons and other general directions, and any point lower than this will not be easily seen by the students seated in the middle or rear of the room.

The next question for the architect to consider will be the width of the blackboards. On this point I wish to say that not 1 square foot more of blackboard material should be placed in a schoolroom than is really needed. The reasons for this caution are these: Good blackboard material is expensive, and hence it would be a waste of money to put in more than is necessary. But a more important reason lies in the fact that blackboards absorb, under certain conditions, nearly, if not quite, 50 per cent of the light that strikes them. Since they are, for the most part, placed near those pupils who are farthest from the windows and who can least afford to lose the absorbed light, it is plain that no more blackened surface should be placed on the walls than real needs demand. This is important. If those designed for the use of pupils in the first, second, and third grades are 28 inches,

those for the fourth and fifth 32 inches, those for the remaining grammar grades 3 feet, and those for high schools 40 inches wide, we are very close to the best arrangement and to the exact amount of blackboard surface needed.

The next point to consider and one of prime importance is the material to be used for blackboards. Wood is no longer advisable, and no discussion of this seems necessary.

A fairly good blackboard can be made by using a good quality of cement thoroughly colored with some dull black material and so securely plastered to metal lath on the walls that no hollow sound will be heard when the chalk is being used. This difficulty can be overcome by constructing a solid, even backing of wood for the lath. Care must be taken, however, to prevent the expansion in such a backing from cracking the cement after it begins to set, for the moisture absorbed by the wood will cause it to expand. If the inner walls are made of brick or cement, no such difficulty will arise. The cement must be put on evenly, the surface finished as smoothly as pure cement can make it, and colored with great care. A slight tinge of dark green mixed with the black will be acceptable. One chief difficulty in the use of cement for this purpose is the fact that it must be put on quickly after being mixed and usually not enough can be mixed at one time to finish a room. As a result of two or more separate mixtures, there is liable to be slight differences in color which will be noticeable when it is dry. Of course this difficulty may be overcome when several workmen cooperate. There is danger, too, that after a time the coloring matter will fade or leach out when the board is washed. A cement board is likely to be harsh at first and therefore to cut the crayon too freely. There are a number of patented mixtures using cement as the chief ingredient and all of these, as far as I have been able to judge, are open to these objections. It makes a comparatively inexpensive board, but in my opinion should not be used in first-class school buildings. It is hard to keep clean, and will not last as long as slate or glass.

Slate of a dull black color when cut in large slabs carefully and evenly set is perhaps the best material now readily available in this country. It is expensive, but will last indefinitely and with reasonable care can be kept comparatively free from the dirt and oil gathered from the hands of the pupils. The most serious objections to slate are these: It is noisy and the joints never fit very closely and evenly. This latter defect often causes the eraser to catch and this often knocks it out of the hand of the pupil. This is not only troublesome to the worker, but it will throw a good deal of crayon dust into the air. Unless slate boards are set and fastened firmly to the wall, they will warp and render these joints still more troublesome.

Some recent experience has proved to me that poorly set slate boards are a real nuisance. But guarding against all these difficulties, it is safe to use slate in our best school buildings.

There are on the market several kinds of blackboards made of paper, paper-like material, or wood pulp rolled and pressed into sheets of any reasonable length. They can be colored to suit, and when well set are fairly satisfactory. The term "hyloplate" is the name by which these are generally known. The main troubles with these are they absorb water when washed or during damp weather, become oily, and in time buckle and chip. My experience with them indicates that they will not stand hard usage very long. It is not advisable to use such material in the best school buildings.

In England the best blackboards are made of glass. A sheet of glass of good quality and thickness is slightly but evenly ground on one side. The reverse side is painted the color desired, and when dry is firmly set with the ground side out. The color shows through so as to seem to be on the surface, while the roughness caused by the grinding cuts the crayon and thus leaves a clear white mark on a black background. It is very necessary that the grinding agent does not cut too deep and leave the surface too rough, for glass cuts the crayon freely and would, under this condition, introduce the difficulty of an undue amount of crayon dust, which, as every teacher knows, is irritating and harmful when breathed.

The great advantages of glass boards are obvious. They are easily cleaned, do not absorb moisture or oil from the hands, do not warp or buckle, last indefinitely—indeed they improve with use—and can be made to fit at the joints more perfectly than slate. They are not used to any extent in this country, but I am persuaded that in many respects they are superior to slate, and in time will be used almost exclusively in our best buildings.

There are a number of other forms of boards, but cement, slate or glass are the best, and in the long run are most economical. Of these I prefer glass. When this can not be obtained, slate should be chosen for all good buildings.

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## DOORS.

Whether the laws require it or not, no schoolhouse should be constructed with doors set to swing in. In many States there are laws now in force commanding outward swinging doors in all public buildings, including schoolhouses. Furthermore, some recent disasters, notably the one in Ohio, emphasize the necessity of so fastening outside doors that they may be easily thrown open from the inside. In the past few years patents have been issued for fastenings which render the door secure from the outside, although it will open

readily at an 8 or 10 pound pressure from within. These make it possible to keep the building locked during school hours so as to prevent intruders and thieves from entering, yet in no way endanger the children in case of fire, for a small child can push them open. But so far as I know no actual tests of it have yet been made during a panic induced by a fire.

The style of interior doors deserves some attention from the point of view of beauty and cleanliness. The ordinary stock paneled doors are not, according to my experience, at all satisfactory. They shrink a good deal, catch the dust on the ledges supporting the panels, and are often easily split. The best doors are, I think, smooth on both sides from bottom to top, and built up of different layers of wood glued together, with the grain of the core and the outsides running at right angles. The central or inner layer can be constructed of light, well-seasoned pine or poplar boards, tongued and grooved and thoroughly glued together, and running crosswise. Over these a veneer of wood selected to match the finish of the rooms and halls and set vertically to the floor is carefully fastened and glued to the core. This gives a comparatively light door, which will not easily warp or split. Such a door is readily kept clean and when properly finished is really more attractive than the regulation paneled door. These are not theoretical doors, but they are used in some of the best school buildings of the Pacific coast.

In this connection I can not neglect the opportunity to protest again against the use of the so-called "carpet" strip, or threshold strip, so frequently put under inside doors to insure them swinging clear of the floor. These strips may and do have a reason for being in a home where carpets or rugs are spread over the floor in front of doors, but they are in the way, and serve no necessary purpose in the school building. They catch dust, make it hard to sweep or brush the floor, and in addition are stumbling blocks to the children. A level floor offers no impediment to a door set vertically and secured by strong hinges.

It is of course necessary to set a door slightly above the floor, so it will not drag when opened; but if the floor is carefully laid, the door frames vertically set, and the door solidly hung there will be no trouble. It is a great relief to get rid of the "carpet" strip for the sake of cleanliness, and the floor and room present a much neater appearance without it.

Save in those instances where it is necessary to transmit light to halls or inner rooms, it is a mistake ever to put glass in schoolroom doors or above them. A schoolroom needs privacy in order that the teacher and the children may do the most effective work. Besides, even if the glass be frosted or ground so as to render it translucent,



a gust of wind or a bump of passing students will likely break it. Experience with such doors warrants advice against their use.

Transoms serve no purpose save that of offering some little aid in very hot weather by permitting a draft from the room into the hall. But there are a hundred needs for preventing drafts where there is one for inducing them. Transoms rarely fit closely and at the same time work with sufficient ease to make it possible to use them when needed. With the plenum system of ventilation they are troublesome, because of the leakage from the room. They are often neglected, and hence usually dirty. They furnish a ledge for the accumulation of dust and cobwebs and thus often give a room an untidy appearance. It is better in general to dispense with all transoms, for they are more trouble than they are worth.

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### CLOAKROOMS.

The problem of supplying cloakrooms and lockers for high-school pupils is a very different one from that of supplying comparable conveniences for the grammar grades. Generally speaking, high-school pupils are moving about from room to room throughout the day, and they rarely if ever finish a session with a recitation in the same room in which they began; they have no room which they can properly call their own, though they may have a "class teacher," or one to whom they are attached for a term for special help and advice; they must have lockers where books and materials can be kept during the hours of the day when not in use, and of necessity these rooms and lockers must be located where general convenience demands. It goes without saying that in high schools there ought to be separate cloakrooms for the boys and the girls, and that where possible these ought to be well separated from each other in order to prevent crowding in the halls and also to insure greater privacy for each. In a large school there ought to be at least four of these rooms, two upstairs and two on the lower floor, the girls of the third and fourth year classes using the one upstairs, while those of the first and second years would use the one below, or vice versa, according to arrangement of classes. The same provision also should be made for the boys. In small schools one for each will suffice. These rooms ought to have abundance of light, be well ventilated and warmed, and should be located where they can be readily supervised and frequently inspected. It is a mistaken policy and poor economy to stint in the matter of cloakrooms and lockers, with reference either to space or to furniture. Make these rooms neat and attractive, and then it is the duty of those in authority to see that they are carefully kept and

in no way abused by the pupils. It is sometimes more than distressing to see how such rooms are misused, especially by the boys. Locker doors are broken open for no other reason than that a lazy boy will not go home for his forgotten key. Walls are defaced, and an air of general carelessness is likely to prevail. The safe thing is to make the rooms attractive and deserving of good treatment, and then the fault should lie with the teachers if they are not so kept.

The method of putting lockers all along hallways has some advantages, notably in their management and general care, but they are unsightly; they restrict hallways, invite congestion, are hard to ventilate and difficult to keep free from dust. The hallways of school-rooms, when they are properly constructed and lighted, offer one of the best opportunities which the building affords for artistic treatment and æsthetic influence. A wide hallway with good floors, neat panelings, artistic tinting, good light, and a few well-chosen pictures selected and framed to suit, will exert a greater influence on young people than practical Americans are prepared to estimate.

It is my earnest conviction, and I believe it is the general professional opinion, that hallways should never be restricted or despoiled with rows of hat pegs or even closed lockers—open ones are an abomination.

In general, it is both unhygienic and inconvenient to locate cloakrooms in basements, and especially so when lockers are needed. These rooms are rarely well ventilated and lighted, are too far from the teachers for inspection and supervision, and they invite pilfering. Bicycle stalls can be arranged in basements, but the demands on these will be limited, and they will need very little care.

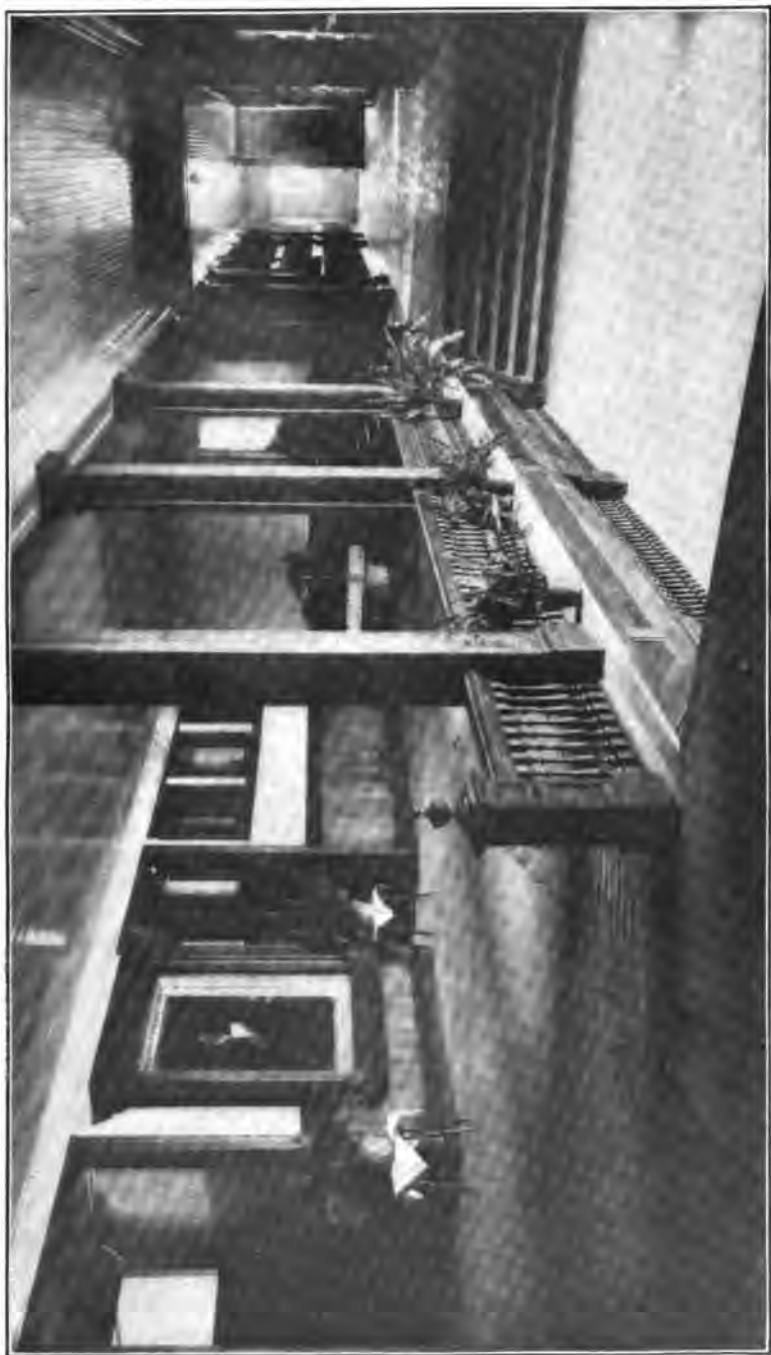
In taking the position that cloakrooms for high schools should not be situated in basements, I am conscious that I am opposing a more or less prevalent custom. The basement is the place where architects find it most convenient to locate them, and it is argued that there is little or no need for pupils to remain long in such rooms and that it is useless waste of space to locate them above the basement. It is readily agreed that it is less expensive to put them in the basement, but it does not always happen that the least expensive is the best, or even the most economical in the long run. Of course, if a basement floor is not more than 2 feet below the surface, and the lighting, heating, and ventilation of the basement rooms are looked after with as much care and made as effective as in rooms above, there can be little rational objection to using well-appointed space in basements for cloakrooms. But there are so many basements in small or medium sized buildings 4 feet or more below the surface of the ground, with small windows and dark rooms, that it is rarely advisable to suggest this as a place for cloakrooms. In large buildings,

where the problem of securing proper proportion does not call for bringing the main floor close to the surface of the ground, basement floors can be put at or near a level with the surface of the ground, and, of course, such basements would offer a convenient and sanitary location for cloakrooms. But even in large public high schools it is not altogether wise to make the basement a gathering place. The license suggested by a basement when so used will certainly operate to make any school more difficult to manage, for proper supervision will be very much more difficult to maintain.

It is my belief, as I have said, that care should be exercised in making cloakrooms as neat, attractive, and sanitary as any other rooms in the building. If you wish to forestall defilement and lax discipline in any public institution, especially in schools, it can not be done more effectively than through hygienic toilets guarded with zealous care, or through tasteful rooms where students congregate, such as cloakrooms, gymnasiums, or assembly halls. It is rarely possible to make a basement locker room a pleasant, attractive place, especially for girls.

The form of lockers used will to some extent depend upon where they are placed; but for obvious reasons they should be well ventilated and at the same time strongly made, so as to offer no temptations to pilfering. When placed in the basement they are more exposed to meddlers and thieves than if placed on the floors above, and so must be more securely constructed and supervised more carefully.

In grammar schools each class room must be provided with a well-lighted and well-ventilated cloakroom. It is not necessary to make separate cloakrooms for the sexes if such rooms are correctly placed, sufficiently large, and properly equipped. In small buildings of not more than four rooms, it is often easy to arrange separate cloakrooms for the sexes, and when it can be done without inconvenience or undue expense, it is desirable; but in large buildings much confusion and its incident difficulties can be avoided by giving each class room one common cloakroom. Entrance to the cloakroom should be from the schoolroom and at the teacher's end of the room. This plan gives the teacher complete control, and prevents anyone from entering it during school hours without the teacher's knowledge. It permits of ventilation and heating as described elsewhere (see p. 99), and through the use of monitors to distribute the wraps is convenient and wholly out of the way. Several years of observation and experience with cloakrooms so arranged for grammar schools have convinced me that no better arrangement of them can be made within reasonable expense and wise use of space.



MAIN CORRIDOR, JOHN MILLEDGE SCHOOL, AUGUSTA, GA.



CORRIDOR, WEBSTER SCHOOL, ST. LOUIS, MO. WM. B. ITTNER, ARCHITECT. WHAT DO YOU THINK OF THE EDUCATIONAL INFLUENCE OF THIS HALL?

## HALLS OF SCHOOL BUILDINGS.

From the teacher's point of view, there are some requirements in the construction of halls in school buildings that deserve more consideration than architects are, at times, inclined to give.

The units of the school building are the class rooms, which, of course, deserve prime consideration. But it is a mistake to sacrifice too much in the form, size, and lighting of halls in order that any specific scheme of class rooms may be carried out. I wish therefore to emphasize some essentials in the construction of halls and to urge teachers to see that these are called to the attention of architects and the members of boards of education.

They must be wide enough to prevent congestion while students are gathering in the morning or passing between classes and during intermissions, and especially at dismissals. It is not possible to specify definitely what the width of any hall should be without first calculating how many students are likely to use it at any one time, but there are certain ideals which ought to be considered. In high-school buildings of medium size the main hall should be at least 14 feet wide; 16 feet is better. A hall 12 feet wide for grammar schools is more spacious for grammar grades than one 14 feet wide for high schools accommodating the same number of pupils. This is true because of the size of the pupils, and because it is rarely necessary for pupils in the grammar grades to pass from their room in a body save at intermissions. In high schools the rule is for a complete change of rooms for all students at the close of each recitation period. This at once makes it clear that the hallways of high-school buildings are used much oftener than those in buildings designed for the grammar grades. Besides, greater precautions are necessary at this stage of life in mixed schools to avoid all excuses for that familiarity which crowded halls would suggest. But aside from these reasonable and just claims for wide halls, it is always expedient to keep in mind dangers from a blockade in case of fire. Fire drills will lessen the danger; still, nothing but plenty of room will prevent trouble when a lot of people, old or young, lose their wits and stampede. A deficiency at such a time is too serious to call for further emphasis.

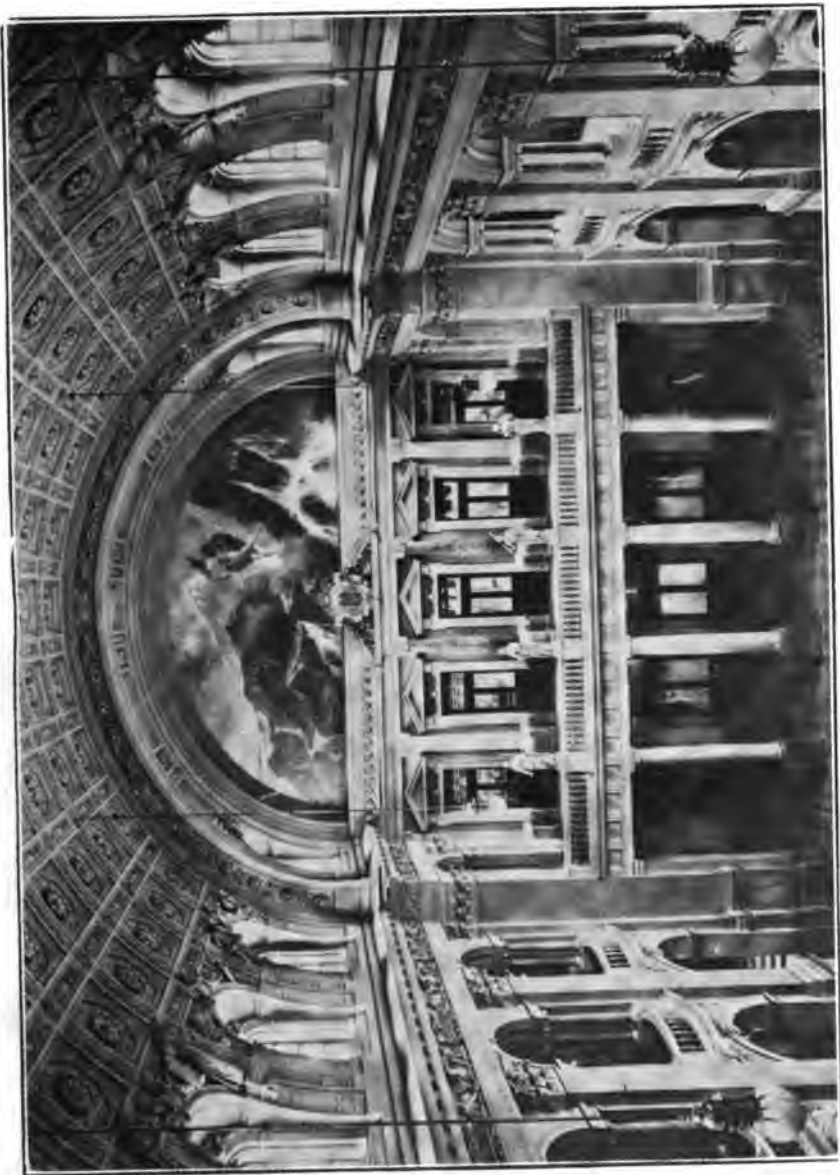
Another imperative need for wide halls, in my estimation, is this: Spacious halls offer perhaps the best opportunity afforded in any part of a school building for the location of pictures, for mural paintings, and those touches of art which exert such a powerful, though silent and unconscious, influence upon the lives of young people. A cramped narrow hall will not admit of effective decoration.

Many of the illustrations presented in this bulletin will emphasize what has been said above and I trust will suggest to school boards that it is not a waste of money to provide wide, spacious halls.

Another essential is plenty of light. In this country it is almost universal to flank the two sides of a hall with class rooms, and depend on doors at the entrance and windows at the ends of the hall for light. In Germany it is the prevailing custom to have class rooms on but one side of a hall, and as a result they have better light in the halls in their newer school buildings than we do. The American plan of construction gives a more thoroughly centralized building, and for the same number of rooms a less expensive building, but it demands wider halls, and introduces a great deal more difficulty in supplying them with sufficient light. The German type of building introduces difficulties in heating and ventilation which the American type readily overcomes. I believe that one of the weakest points about our types of school buildings is that the halls are not generally attractive and are rarely well lighted.

The floors of halls in high-school buildings are subject to more wear than are those of the class rooms, and therefore require more care and deserve more consideration in their construction. There is a growing tendency to make the floors of halls of light-colored tiles set in a strong base of cement, or to embed in cement broken bits of marble of various colors and then to polish them to an even surface. Some modern buildings in this country have used plain cement. There are many things to be said in favor of tile floors. In the first place they are clean, can be made durable, they are readily cleaned, nonabsorbent, and render the hall lighter and more cheery than wood or any darker material. Tiles, however, are cold, but since halls are to be used chiefly for those who are passing to their rooms or from room to room, there can be little fault found on this account. Perhaps the most serious objections which can be offered to their use are that they are expensive and noisy. Good oak floors properly cared for will last a long time, and they are very effective when kept clean and well polished. But they require a great deal of attention, and in the end are perhaps more expensive than tile floors. If hard pine or maple is used, the precautions mentioned under the chapter on "Floors" ought to be kept in mind.

Halls are more effective and less objectionable when there are no projections to obstruct and no constrictions to hinder. A long spacious hall, terminating at each end in a tasteful stairway with good light, is suggestive of a dignity and a decorum to which students will unconsciously respond.



CENTRAL HALL, UNIVERSITY OF LEIPZIG, GERMANY.





A. FOYER, DE WITT CLINTON HIGH SCHOOL, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT.



B. FOYER, STUYVESANT HIGH SCHOOL, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT.

## STAIRWAYS.

In two-story buildings designed for high schools there should be at least two stairways from the first floor to the second, and in large schools there should be more. These stairways ought to be situated as near the ends or outer walls of the building as the plan of construction will permit. For when so located there is a natural division of the students into groups, and, generally speaking, this, in case of panic, will prevent that congestion on stairs and landings which is dreaded by all teachers who take precaution against loss of life in case of fire. Besides, this location facilitates passing up and down stairs between recitations. One hundred students in double file can easily descend a broad, well-lighted stairway in 35 seconds, and with proper fire drills can reduce this time considerably and with all safety, so that they can emerge from the building in a minute to a minute and a half. Experience has taught me that 1,000 children, in a two-story grammar-school building furnished with four stairways, can be trained to get out safely in a minute, if the stairways are properly placed and wide enough. Another reason for placing the stairways leading to the second floor near the ends or opposite sides of the buildings is the fact that fires, as a rule, originate in the central part of the building, or if they do not originate there the smoke is likely to gather there and render a central stairway dark and forbidding. Besides, there is a better chance for light near the outside walls and less inflammable materials, especially in brick, stone, or cement construction.

The stairways should be of fireproof construction, especially in a wooden building. The prevailing custom is to make wooden stairs in wooden buildings, and more resistant stairs in stone, brick, or cement buildings. A moment's thought is sufficient to show that in this regard wooden buildings need greater care in the construction of stairs than any other sort of building.

It is in no sense unreasonable to insist on fireproof stairs in all large two-story buildings, especially now that the material is within reach of all. Steel frames incased in cement, and with treads made of the same material render stairways reasonably safe against fires and also insure much greater permanency. The width of a stairway will of course depend in part on the number of students it is designed to accommodate; but in all cases it should be wide enough for two adults to ascend or descend abreast without crowding. In large schools there should be room for three adults on the same tread at once. In general, 5½ to 6 feet in width will give plenty of room save in very large schools. The height of the riser should not exceed 6 inches, and the width of the tread be not less than 10 inches in the clear; 12

inches is better. There should be a rectangular landing half way up and this should be in width nearly, if not quite, double the length of the tread. Such a width will help to prevent blockades in case of fire, and will insure better light on the stairs. It may be said here in passing that the habit of decorating this landing with potted plants, box seats, etc., needs questioning. If plants can be placed safely out of the way, there can be no objection offered. Some day we may have enough faith in the value of art and enough artists in our country to decorate the walls above these landings as well as in the hallways with mural paintings of a worthy sort, and then they will not seem so bare and cheerless.

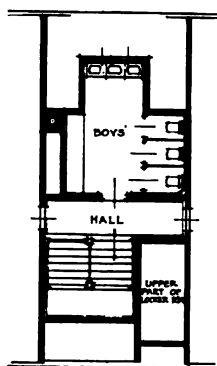
Much has been written on the question of whether or not stairways should be boxed in or finished with open work, surmounted with a handrail. Those favoring the former method have cited instances where children have fallen over and received serious injuries where open balustrades have been used. But the danger from this sort of construction seems very slight, indeed, where due care is taken to make these high enough and sufficiently strong. In my mind the most objectionable feature of the open balustrade along stairways is the fact that in mixed schools they do not sufficiently shield the girls as they ascend from exposure to the view of those on the lower half of the stairs. At the high-school age, girls still wear short skirts, and in mixed schools stairways thus constructed furnish opportunities which may be very objectionable. On the other hand, the boxed-in stairway is much darker and far less acceptable from the standpoint of appearance. It therefore seems wise in building for mixed schools to recommend a balustrade with the lower part solid and the upper part more open.

The prevailing custom in the newer buildings is to make these balustrades of iron wrought into more or less elaborate patterns. The matter of keeping stair railing free from dust ought to suggest to builders the need for designs easily cleaned as well as beautiful.

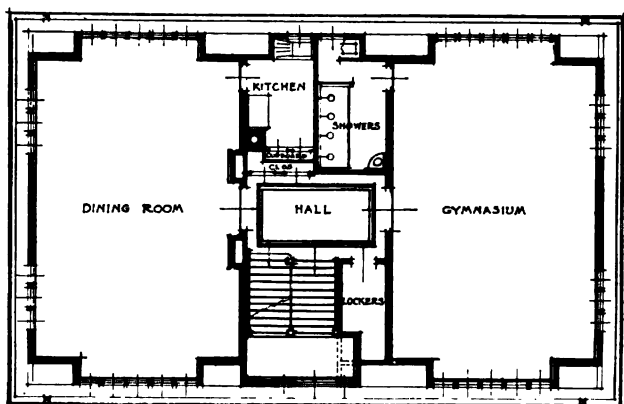
When stair treads are made of cement, the corners next the risers ought to be left rounded instead of square, in order to facilitate keeping them clean. Dirt caught in rectangular corners is hard to remove and by reason of this fact is often left undisturbed. Where wooden stairs are used a triangular piece of tin made to fit the corners closely, saves much work in sweeping and gives better results in cleanliness. It is a wise procedure, in the construction of fireproof stairways, to use the very best cement obtainable, so that the treads may resist wear, stand level or nearly so, and especially to render the exposed edges strong and nonslippery. Handrails are needed on the wall side as well as along the outer side. These, however, should not extend more than 3 or 4 inches from the wall, and should be at least



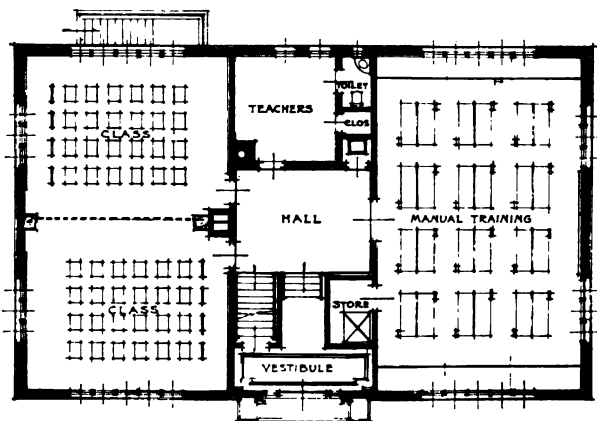
CONCRETE STAIRWAY, HEMPSTEAD SCHOOL, ST. LOUIS, MO. WM. B. ITTNER, ARCHITECT.



- THIRD FLOOR PLAN -



- SECOND FLOOR PLAN -



- FIRST FLOOR PLAN -

EAST AND WEST SIDE UNGRADED SCHOOLS, NEWARK, N. J.



BOYS' TOILET ON THIRD FLOOR, PUBLIC SCHOOL NO. 62, NEW YORK CITY.  
INDIVIDUAL WASHOUT TANKS ARE PROVIDED.



3 feet above the treads. They are often too low to offer satisfactory assistance in going down the stairs.

The short flight of steps through the main entrance to the first floor needs to be wider than those in the stairways proper, and can be constructed of stone or cement. The back stairways leading from the first floor to the basement can be more safely placed near the center of the building, for they are not likely to be used in case of fire.

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### LATRINES AND URINALS.

For buildings not over two stories high the most economical and, on the whole, the most isolated and convenient place for toilets is in the basement. With this location much expense is saved in plumbing, better floors can be made, flushing and washing can be done more safely, good ventilation can be more easily maintained, and privacy is safeguarded. Where sewers are not provided, the plan suggested in the chapter on water supply can be followed. Disconnected out-houses introduce many difficulties aside from those suggested by inclement weather, lack of space, and neglect.

The rooms in basements where these necessities are placed should be flooded with sunshine some part of each clear day, and under any condition they must be thoroughly lighted. In placing latrines and urinals great care should be taken to avoid obstructing the light and also to so face the stalls that they will receive as much direct light as possible. To meet these demands most easily for small or medium sized schools, a long narrow room in a basement looking toward the south will generally prove most satisfactory. A double row of latrines or urinals is almost certain to make lighting unsatisfactory, and it is better to put them singly against an inner partition not more than 10 or 12 feet distant from the windows. At the point nearest the door of entrance into the boys' toilet place the urinals, and the latrines at the point farthest from the door. This arrangement will also make plumbing more simple, get the outflow into the sewer a little nearer the middle of the building, and hence make it unnecessary to have a long duct to connect with the ventilating stack. This latter advantage will operate in giving more rapid ventilation through reduced friction. In order to make this room as light as possible and at the same time to preserve privacy, the windows may be glazed with ribbed glass and protected from without by a strong, coarse-meshed wire screen. In addition to the flushing tank for the latrines and drip pipes for the urinals, a spigot for hose attachment is essential for washing floors and flooding the urinals. If these



rooms are well kept and sufficiently large, there is no special reason why lavatories should not be located there also; but if space permits it is better to place these in an adjoining room.

It is best to make the floors of these rooms of cement, or with a base of strong cement well tamped and carefully evened to the slope needed. After this base has thoroughly dried, lay a thin coating of hard asphaltum over it. This will render it less porous than if it were all cement, and also by reason of this fact prevent the rise of ground air into the room. For this purpose asphaltum is superior to almost any surface which can be made at reasonable cost.

The facings of the walls should be of light glazed bricks, or white tiles, in order to prevent the absorption of light and to make it easy to scrub and disinfect the walls. When walls are so constructed there is also much less liability for defilements in the way of indecent drawings or indelicate scribbings, altogether a too common indiscretion, if not a vice, with schoolboys. The ceiling should be constructed with a view of preventing as far as possible the escape of any possible odors into the rooms above. Perhaps all that can be expected in most school buildings is a good coating of cement plaster finished smooth and painted when dry with a white paint so mixed as to have a sort of glue-like texture more or less impervious to the air, and able to withstand occasional washings.

It is generally wise to expose the plumbing connected with the water supply in order that inspection and repairs may be made without undue trouble or defacements.

In grammar schools the number of seats that will suffice for the girls' toilet can be determined approximately by dividing one-half of the total number of pupils the building is designed to accommodate by 15. That is to say if the school is built for 600 pupils there ought to be 20 seats for the girls. For the boys the number of seats needed can be approximated by dividing by 25. Hence for the accommodation of 300 boys 12 seats is generally ample. The number needed, however, will depend to some extent on the distance the children will have to come. Obviously, if a majority go home for luncheon, the demands will be lessened. The number of urinals need not be so great, say 10 for such a building. There should be enough, but not one too many. In this connection it ought to be said that principals of grammar schools can save a good deal of congestion and likewise prevent moral contamination by so arranging the program that dismissals at recess time will be a few minutes earlier for the primary classes than for the upper classes.

In high-school buildings the proportional number of seats can be reduced a little from above figures, for study hours and greater freedom in high schools, together with the advanced age of the children,

operate to prevent as much congestion in toilet rooms as is often found in elementary schools where programs are more rigid and natural demands more frequent.

Individual urinal bowls are in general very unsatisfactory anywhere, but they are especially objectionable in schools. It is almost impossible to thoroughly flush them, to keep them clean, and to properly ventilate them. They demand more attention than a school keeper can give to them, and for careless schoolboys are altogether objectionable. Trough urinals are still worse and should not be used anywhere. The best form of urinal for school purposes, especially for grammar schools, seems to be that made by stalls opening at the bottom in a narrow slot through which the flushing water, the urine, and the ventilating drafts enter. The water is caught in a trough below and quickly carried to the sewer connections. The air is carried through and around these troughs to the exhaust duct connecting with the ventilating stack elsewhere described. (See Fig. 9.)

The choice of material of the sides and backs of the urinal stalls will, of course, depend partly on the money available. A good quality of slate, hard, seamless marble, or perhaps better than all, glass slabs are to be recommended. Where glass is used, the plates should be ground on the unexposed side to render them nontransparent. This will necessitate the use of two plates placed back to back for the partitions between the stalls. Glass has the decided advantage of being nonabsorbent and of being readily cleaned. The outer edges of the glass plates should rest in a framework of non-corroding metal to prevent breakage. Naturally, the back of the stall should incline forward from top to bottom and receive the cleansing spray across the top.

In two-story buildings there should be on each floor above the basement one seat for the girls and one for the boys. These should be used only for emergencies. On each of these floors also the teachers should be accommodated with both lavatories and toilet necessities, one for each sex. It would seem almost needless to state that these must be well lighted and have good ventilation, but all too frequently this is not done.

All latrines and urinals should be ventilated directly down and through them, so that no odors can escape into the toilet room. This ventilation system ought to be wholly independent of any other in the building. Otherwise reverse currents will always give trouble.

Probably the safest and best means of ventilating the seats and urinals consists in building a separate near-by stack at as convenient a place as practicable, with a stove or grate built into it from the basement in such a way that after the fire is built all of the draft needed for combustion, and that caused by the outflowing heated

air will be drawn through an underground duct connected with the seats and urinal outflows near the sewer connections. This stack can be built in the main chimney, but is not to have any direct communication with any other draft. Sometimes in small buildings the escaping heat from the fires may be made to warm this stack so

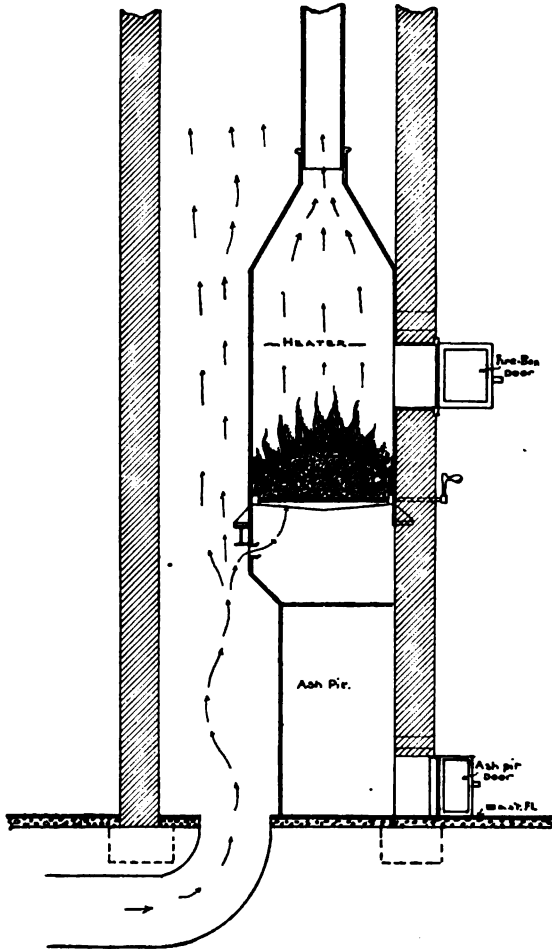


FIG. 9.—A ventilating stack for latrines and urinals.

insure a slow, steady heat without frequent replenishings will save trouble and fuel and insure safer ventilation. When such provisions as here suggested are made and *fire is kept burning*, basement toilets and urinals can be kept pure and altogether unobjectionable.

The seats should have an automatic washout attachment, for school children can not be trusted to regulate the flushing. Where a number of seats are connected with the same trough there must be an occa-

as to aid the outflow of air. Where steam heat is used, steam pipes placed in it, instead of the stove or grate, will serve the same purpose. But even during the winter season when hot fires are needed to warm the rooms, it is safer to supply this ventilating stack with an independent means of heating, so that during the night, and especially during week ends and holidays, this fire may be kept up without the extra expense incurred in keeping a boiler or furnace hot. This fire must be kept burning winter and summer during the school session. To this end it is especially desirable to make due provision for a fire that will last. Hence a large fire box arranged to



A. BOYS' BATHS AND URINALS, PUBLIC SCHOOL NO. 62, NEW YORK CITY.



B. IN PUBLIC SCHOOL NO. 147, NEW YORK CITY. "YES, SIR; WE HAVE A RIGHT TO CLEAN WATER, PURE AIR, AND FUN."

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sional discharge of water great enough to sweep it clean. There are numerous patent devices made to accomplish this purpose, and in general it may be said the simplest is the best. The problem of supplying each separate seat with a flushing tank to be operated automatically when the seat is used, or of furnishing a release to be operated by the pupil himself, is a difficult one. Generally, as indicated above, it is better not to depend on children to regulate matters of this sort. But it is plain that unless the general flushing tank is operated very rapidly some provision ought to be made to wash out each individual seat as soon as used; otherwise, even with good downward ventilation there is some danger of escaping odors. However, if the receiving trough is placed well below the seats and a strong downward draft maintained there is practically no trouble, especially if the intervals between the flushing are shortened during periods of intermission. Where the water supply comes at small cost, and where sewer connections are ample, there can be little complaint when dependence is placed solely on a general automatic flush, for it can be set to discharge at a rate to meet demands. The troubles of plumbing arising from a great number of individual tanks are so annoying and expensive that such tanks are likely to be frequently in bad repair.

In some of the newer schools in Germany the regulation of the flushings is accomplished by means of a clock which can be set so as to effect rapid flushings at periods corresponding to those for intermissions. These clocks are similar in arrangement to ordinary program clocks, but, of course, much less complicated. Any mechanic with a modicum of originality can make such connections with an ordinary clock.

In country schools, where outhouses are necessary, they can be made less conspicuous by covering them with vines, shielding them by a clump of shrubs, or by a latticework fence. The urinals connected with such outbuildings should be in the open air and completely hidden from the playground. One of the best means of keeping the latrines free from odor is to have at hand a good supply of dust gathered from the roads in dry weather, or fine ashes, to scatter over the excreta. To this end a bin ought to be built in each of such outhouses from which such material can be scooped as needed. It is good civics to teach the children how to use such means of cleanliness, and to give them the reasons for using dust, ashes, or slaked lime. Instead of deep pits, or cesspools, it is far safer to have a box underneath the seats, which can be drawn out and emptied as often as needed. It is almost impossible to keep a pit clean and free from odor, even though it is not water-soaked. The outhouse, when such an appurtenance must be endured, demands far more attention than it gets; but it ought to be possible very soon to install in

every country school a system of septic tanks connected with washout toilets. An ordinary force pump to be worked by hand with a supply tank high enough to drive the water through the feed pipes to a washout toilet tank can be installed at almost any school, and will be installed when people are sufficiently informed of the dangers of open vaults. Such conveniences would have a good reflex influence in the homes represented. There are many country schools so located with reference to a water supply that, with a little planning on the part of the teacher or county superintendent, water can be carried from springs or running streams to a sunken tank on higher ground and from there distributed for use in the toilets, the garden, and, if pure, to the schoolroom for drinking purposes. What we need to make our country schools more wholesome and attractive is not so much more money, but more intelligent and vigorous supervision. There are many opportunities not utilized simply because of a lack of suggestion and definite guidance. A good sanitary, decent toilet system at a country school will in time set better standards in this regard for the homes.

At present a well-defined movement is on foot to make war against the hookworm disease which is prevalent in the South, but by no means confined to that section of the country. As is well known, this enervating and depleting disease is caused by parasitic worms which fasten themselves to the inner walls of the intestinal tract by means of small hooks; hence the name hookworm. Naturally, those afflicted with this disease endanger the health of others when by any indirect means these parasites discharged in excreta enter drinking water or food supplies of any sort, such as fruits or garden products, or when they come in contact with the skin; and it seems to have been proved that they most frequently enter the body in this way. Children, then, who go barefooted must be protected.

It should not require arguments or further plain talk to make clear to any one who has enough common sense to serve on a school board or to supervise the construction of necessary conveniences at schools, the urgent necessity for immediate relief from the vile outhouses so often found in connection with country schools, not to mention country homes. It will not suffice to teach people how to cleanse themselves of these pests; they must also be taught how to guard themselves against attack. Every county superintendent, every teacher who is worthy the name, and every school board measuring up to the responsibility accepted, must know these facts and plan accordingly if this disease is to be eradicated or even checked. I firmly believe in a democratic form of government, but there are times when one longs for autocratic power to compel people to be clean, or at least to make it possible for children to learn to be clean and worthy of the name *homo sapiens*.

**BATHS.**

It is no longer an experiment to install in public-school buildings bathing facilities for school children. Naturally baths are most needed in large city schools, especially in those sections where foreigners and poverty-stricken families generally congregate. But what a glorious thing it would be if country and village high schools could all be supplied with baths, for all who know country conditions generally know that country children rarely have access to a bathtub. Boys bathe in summer in streams and "mudholes," chiefly for the fun of it. Even this questionable method of ablution is generally denied the girls.

It is safe to say that not one country child of school age in a hundred has even regular weekly tub or shower baths throughout the year. With modern windmills, driven wells, storage tanks, air-pressure tanks, and gasoline engines, country schools and country homes are no longer of necessity compelled to handle a water supply at a great disadvantage. One part of the social mission of the schools consists in introducing into the homes better facilities for plain hygienic living, appliances which will bring surcease from much useless drudgery, and those modern conveniences which save so much time. Every country school should therefore be supplied not only with pure, wholesome drinking water, but an ample supply for baths, lavatories, and toilets.

Facilities for bathing form as much a part of the equipment of the best new schools in Germany and England as those for heating and lighting. It was my privilege to examine a number of these and to be present while large classes of boys were bathing, and, in order to make this topic as suggestive as possible, I will try to describe what I saw in one of the newest and best schools in Munich. Through permission of the royal authorities and the courtesy of the director, I made a careful study of the school building at Elisabethplatz, and especially of the bathing facilities there offered. This is what is known as a *Volkschule*, and was built in 1902, at the cost of 700,000 marks (\$166,600). There were four rooms in the basement given up to this purpose—a dressing room, a drying and wash room, a furnace room, and the bathroom proper. The boilers were so arranged and connected that the exact temperature of the water could be regulated by the attendant without recourse to an emersion thermometer. That is to say, in the feed pipe leading to the baths there was stationed a thermometer which registered the temperature of the water as it was being used, and by a proper mixing of the hot and cold water the required temperature could be easily and quickly secured. The boilers were large, well incased to prevent radiation, and arranged to use the surplus heat for drying purposes, and to furnish the wash room



with the necessary hot water for the washing of towels and the short cotton trunks used by the bathers. These were both sterilized carefully by heat, so that no objection could be found on this score. The dressing room was on the opposite side of a narrow hallway from the bathroom, so that the children when ready could march directly into the bathroom, each taking from a basin in passing a small cake of soap. The bathroom was floored with cement and lighted on one side by corrugated translucent windows. Around the walls was a series of small booths, each fitted with an individual shower. These were to be used by the older girls. Near the center of the room there were three basins sunk in cement, each connected with the drain pipe. These were about 12 feet long, 3 feet wide, and 8 inches deep, and were placed side by side, with a space of 2 or 3 feet separating them. Directly over each of these at the proper height were spray pipes, so constructed as to throw the water into the basins. The room was properly heated and ventilated, the latter a very necessary condition for healthfulness.

In this special school it was customary for boys to march in, take their regular places about the basins, which had previously been filled with warm water, and at a signal—everything goes by signals and in military fashion in Germany—step in and vigorously soap their bodies and then scrub their feet. This done, the shower at a good warm temperature was turned on by the attendant for five minutes while the boys scrubbed and kneaded themselves, being taught to do this in a careful scientific way. By this time, through the heat of the water and exercise, they were perspiring somewhat freely. Then for two minutes the attendant gradually reduced the temperature of the shower until the reaction from the cold began to show itself pretty clearly, and then at a signal all were out, lined up, and marched quickly to the dressing room, where a clean, warm bath towel and a face towel were ready for each. Around the walls and across this room were little curtained booths with a bench seat in each. Into these where they had left their clothing they took their towels and in a few minutes emerged dressed and combed, ruddy with the exercise. From here they were quickly marched to their room, having been out all told about thirty minutes. Then, under the direction of a vigorous teacher, and in harmony with their own feelings, they went earnestly to work and soon more than made up for the time spent in the bath. In this school all the children—and there were about 1,400 of them—are required to bathe once a week. They may do this at home—in which case they must bring a written statement from their parents—or at school. As a record is made by each teacher of the number of pupils taking the school bath, I found on consulting the figures that almost all of the children use the bath at school. Especially is this true in the lower grades. When one

considers the educational and hygienic significance of this work among the poorer classes of German children—and these children were of this type—he realizes that it is well worth while from many points of view.

On inquiry the teachers told me that the children generally regarded their bath at school as a luxury and offered no objection whatever to it. The fact that it is a practice to put school baths into all new buildings erected in the larger cities of Germany, Scandinavia, and other European countries proves that it can not be very expensive, for much stricter economy is practiced in school affairs there than with us. It costs in the school I have described less than 1 cent a bath for each child.

In an elementary school that I visited in Harringay, to the north of London, I found a bath and swimming pool that cost in the neighborhood of \$10,000, and saw scores of vigorous young Britons reveling in it. Here emphasis was placed on the fun and recreation obtained, as well as on the mere cleanliness secured from bathing. And this emphasis on fun or sport is characteristic of the English character, and has had much to do with producing their wonderful tenacity and staying powers.

From the point of view of cleanliness, and especially from that of economy, shower baths are much to be preferred in school buildings over either tub or swimming baths. In arranging a building for shower baths very little extra cost for plumbing is necessary. The only item of serious expense is that for providing hot water. Some form of heater or boiler is necessary, unless some method of sun heating is adopted, such as is used in many parts of California. There, by means of a series of lenses focused on a water tank, all the hot water needed is readily supplied. But, of course, such a method is only practicable where the climate is very mild, and where days with a high sun are very common. Where gas is accessible, it is not difficult to install heaters, and these are now manufactured in many styles and sizes, and are so constructed that they need little care, are very compact, and can be used at a minimum expense for fuel. It is never advisable to use water from a steam boiler for bathing purposes, because of the impossibility of preventing the water in such boiler from becoming increasingly dirty and oily.

It is easy to see that shower baths in schools are superior to tubs and swimming tanks, for the former require less water, and this is constantly pure; there is less danger in them of the spread from one pupil to another of any contagious skin disease; they take much less time, require less space, and on the whole are more effective.

But it may be asked, how could bathing facilities be installed in a village or country school building where there is no public water supply that could be piped into the building? This can be easily

accomplished now, as I have already suggested, by the use of a wind-mill or gasoline engine in connection with an air pressure tank in the basement or elsewhere out of the danger of cold and storms. By this method water can be forced through a building to laboratories, toilet rooms, faucets, drinking fountains, bathrooms, wash rooms, lavatories—in fact, wherever it is needed. Such a provision for water supply will also lower the rate of insurance and render the building safer for children to occupy, for in case of fire it offers immediate help.

The matter of soap and towels can be left to local communities to settle. Where public opinion warrants the expenditure, it is best for the school to furnish these, for then the washing and sterilization can be done thoroughly. However, there is no decisive reason why each pupil should not be free to furnish his own towels and soap. In general, it is better to begin in this way and thus prevent some criticism.

The position of the baths and dressing rooms in a school basement will be determined in part by the size of the basement and the number of pupils to accommodate; though they ought to be placed where good light and good ventilation are easily obtained, and where the waste water can be carried away most readily. It is never hygienically permissible to allow waste water from any part of a school building, save that passing through the urinals and toilet vaults, to pass directly into sewers. Somewhere outside of the building the ordinary waste-water pipes should be trapped into the sewer so effectively as to make it impossible for sewer gas or odors to come into basements. And this brings up another point. What are we to do with toilets, baths, overflow from drinking fountains, and drainage in general from a schoolhouse, if the building is in a town not supplied with a sewer system, and especially in the country? This has been a difficult question to answer, but I believe relief can now be satisfactorily afforded.

Under such conditions it is generally best to install some form of septic tank. The construction of such a plant for sewage disposal is not difficult nor unreasonably expensive, but it requires care and judgment as well as knowledge of the principles involved. Some of the State boards of health have issued excellent bulletins upon the subject, and it is always well to be guided in such matters by the suggestions of those authorities. A disposal plant of this description (Fig. 10) may consist of (1) a settling chamber, to catch sand and other insoluble mineral matter; (2) a septic tank proper, in which the sewage is liquefied by bacterial action; (3) a "dosing tank" or siphon chamber for automatically discharging the contents at regular intervals to an absorption field through drain tiles laid within a foot of the surface, or to distribution pipes for surface irrigation.

If sufficient land is available and if the topography is favorable, the latter plan is cheaper and more satisfactory than the other. The effluent liquid is not innocuous, but if it is intermittently distributed over the surface of the ground it is soon purified by air and sunlight. An occasional harrowing will keep the ground in good condition. The subsurface method of disposal requires two or more systems of drain tiles, to be used alternately, the change from one to the other being made about once a week. This plan is not satisfactory unless the soil is naturally sandy or porous or unless sand or gravel in liberal quantities is placed about the tiles.

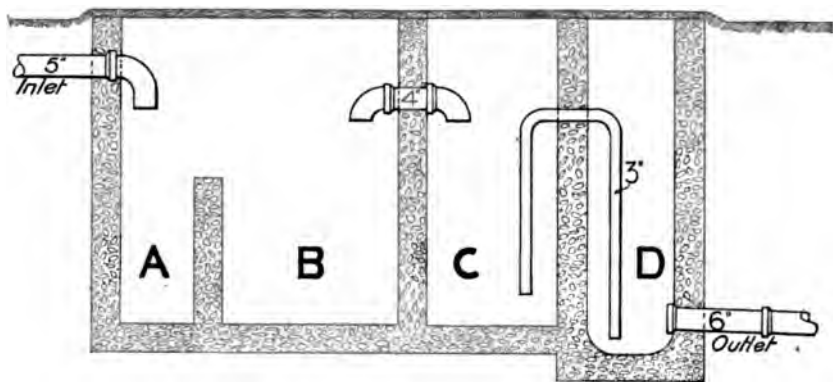


FIG. 10.—A simple form of septic tank suitable for a country school.

A.—Settling chamber. B.—Septic tank proper. C.—“Dosing tank,” from which the absorption or distribution field is “dosed” at regular intervals by means of the siphon. D.—Siphon chamber. A cover of unmatched boards is indicated; the cracks will afford sufficient ventilation, and any two or more of the boards may be easily raised to give access to any part of the structure.

The tanks should be constructed of concrete or of brick, thoroughly cemented and water-tight. They should be covered, but provision must be made for ventilation, and manholes or other openings should be provided for removing the “sludge.” The size of the tanks will depend upon the quantity of sewage expected to pass through them, but, in general, they should be planned to discharge after about eight hours’ use—in other words, once a day for an ordinary school.

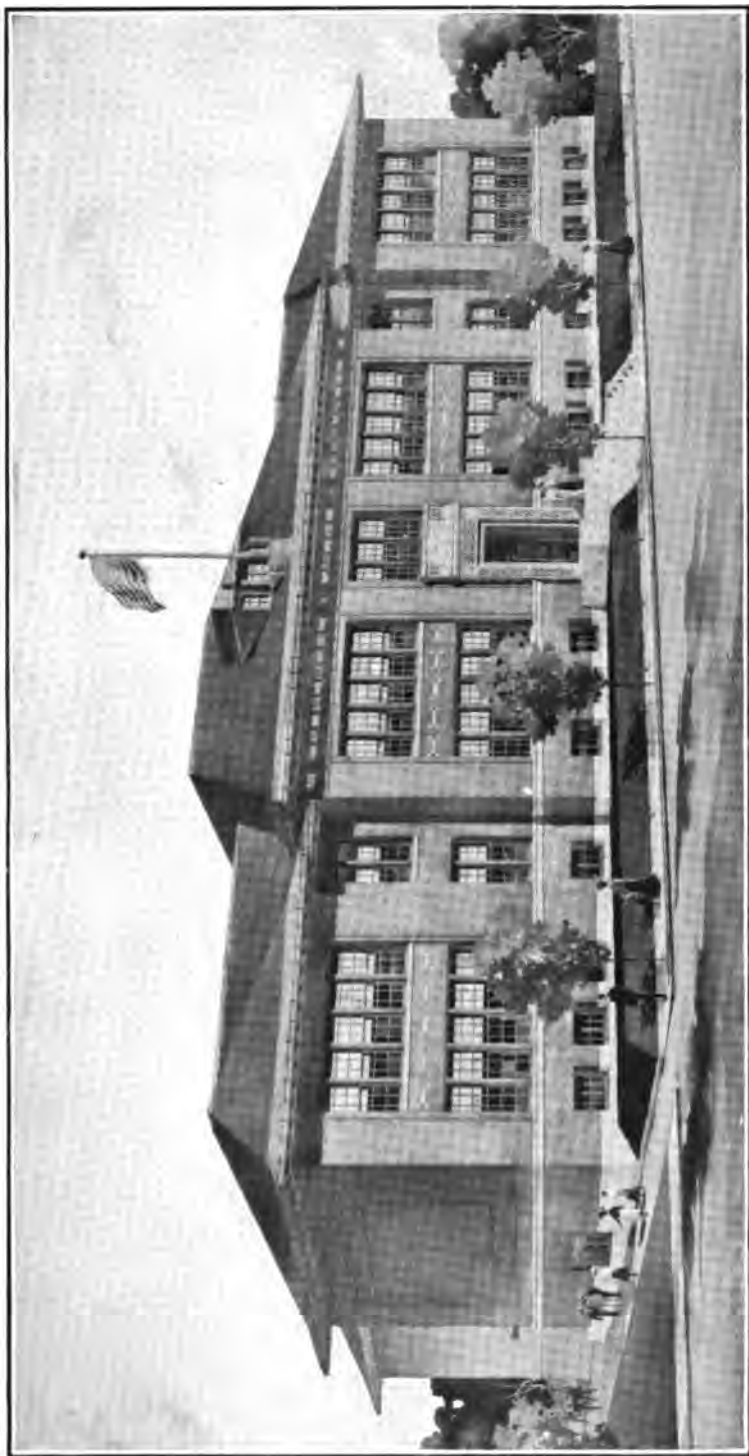
## LIGHTING OF SCHOOLROOMS.

It is safe to say that the demands made on the eyes of school children are greater now than at any previous time in the history of education, and therefore whatever can be done in the way of furnishing better light for our schoolrooms will serve to make school work less fatiguing and indirectly more interesting. And it must ever be held in mind that the problems of lighting, heating, and ventilating schoolrooms are far more complex and difficult than those connected with lighting, heating, and ventilating a living room at home. But it seems that this is a very difficult thing to learn, both for teachers

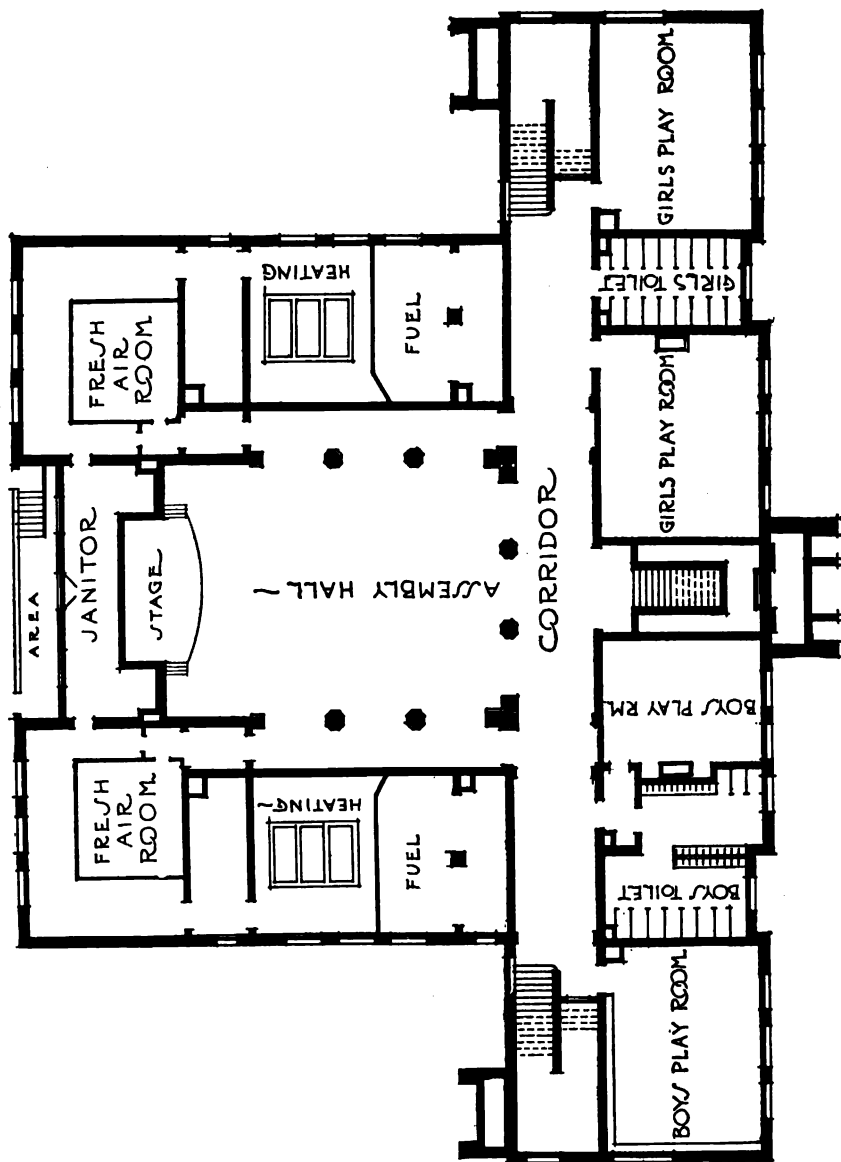
and school officers. If children could be allowed the same freedom at school that they are allowed at home, and if they could have the same average amount of space in schools that they have in homes, then many of the suggestions offered here would be out of place. But at present, when a teacher must manage, direct, and teach from 40 to 50 children in a room so small as to afford in many cases less than 15 square feet of floor space per pupil, many difficulties are of necessity introduced. It requires persistent reiteration and striking objective illustrations of this difference between home and school conditions to bring teachers to act accordingly. The habits they have formed at home in these particulars must be overcome before they can be trusted to be careful of these things in their schoolrooms.

The problems connected with the proper lighting of schoolrooms vary to some degree in different parts of our country. California and all the States of the Southwest enjoy more sunny days, and hence get more regular and continuous bright light than any of the Eastern or Northern States. Besides, in this same region the air is often freer from dust and smoke than it is farther north and east, and this renders both the direct and indirect light unusually strong. During several months of the year the landscape in the Southwest presents a wide expanse of browns somewhat dazzling to the eyes as it reflects the bright rays of the sun. To the north and northeast both the quality and quantity of the light is affected by the dazzling snows of winter or, in some places, the shades of summer. Taking all of these things into consideration, it is impossible to formulate rules which will apply equally well in all parts of our country. Most writers on this subject have, however, neglected to take into account these varying conditions, and have stated their rules and principles as if they could be universally applied, and school authorities who have tried to follow such directions without seeking advice concerning local conditions have in many instances made serious blunders.

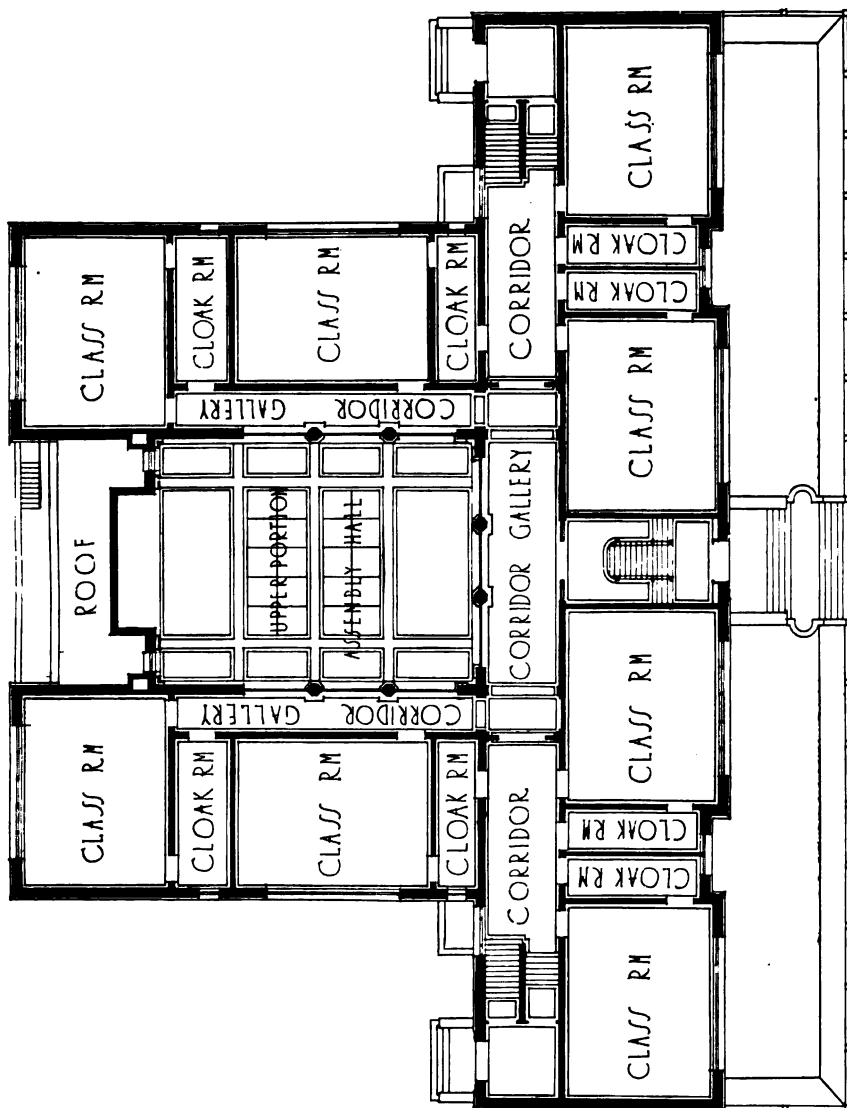
In the northern part of our country where, during the winter season, twilight begins comparatively early in the afternoon, where the shadows are long at noontime, and where cloudy, dark days are of frequent occurrence, it is often necessary to require for each class room an amount of window surface equal to one-fourth of the area of the floor. In the Southwest it will be perfectly safe to limit the total area of the windows to one-sixth of the floor space. It must be understood, however, that these rules will hold good only in those cases where the windows are properly placed and where rooms are of the proper shape and proportion. Furthermore, it is necessary for architects and builders to remember that these figures do not represent the combined space inside the window frames, but the actual glass surface through which the light can enter unhindered.



SCHOOL NO. 154, WASHINGTON, D. C. MARSH & PETER, ARCHITECTS. A WELL-LIGHTED BUILDING.



SCHOOL NO. 154, WASHINGTON, D. C. BASEMENT PLAN.



SCHOOL NO. 154, WASHINGTON, D. C. FIRST-FLOOR PLAN.

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A schoolhouse should be so constructed and so placed on the lot as to admit into the class rooms the early morning sunshine or that of the later afternoon. In the latitude of our country, schoolrooms should never be lighted by windows facing to the south. If windows open into a class room from the south, despite all that can be done with ordinary shades or blinds, bright rays of the sun will find their way into the room during the busiest part of the day and will inevitably dazzle and disturb the eyes of the children as well as those of the teacher. It will prove a mistake in nearly every instance to say that the teacher can so regulate the shades as to prevent all such troubles. If we were to grant that double shades, of which we will speak more at length later on, can be regulated so as to shut out the direct rays of the sun, the fact still remains that very often busy teachers will neglect to regulate them properly, and consequently harm will result. During several years of observation on this point I have yet to see a single class room properly lighted when depending on light from south windows.

While speaking on this point, though addressing his thought to the teachers of Germany and of course to the conditions of German climate, Professor Foster, of Breslau, has said :

No curtains have yet been invented which will keep back the direct rays of the sun and at the same time let the diffused light of the clear sky pass through. Ground glass has been recommended, but it is too dazzling and blinding in the direct rays of the sun and during cloudy days it intercepts too much of the light.

Since the words here quoted were written many attempts have been made to solve the difficulties mentioned by the invention and manufacture of many kinds of shades, but we have yet to see a shade, whether green or gray, buff or blue, which, if satisfactory when exposed to the midday rays of bright sunshine, did not prove unsuitable during the earlier and later periods of the school day. But some one may say that the teacher must adjust the shades as the conditions change during the day. I answer, here is just the trouble; teachers *do not* adjust and can not be trusted to adjust the shades so as to maintain a regular light when windows open to the south.

But, if it is difficult to use shades, to properly regulate a south light is more difficult and, let us say, almost wholly impossible to do so with the common shutters or slat blinds. I have found that even when these are new and all of the slats are in place, just as with the shades, they are very frequently neglected and therefore dangerous; but the difficulty is especially great when, after a short time, all the slats do not close equally tight. Through the chinks thus afforded pencils of light stream in, producing that peculiar painful adjustment of the eyes, which not only induces undue fatigue of the eye muscles but also distracts the attention and annoys the child

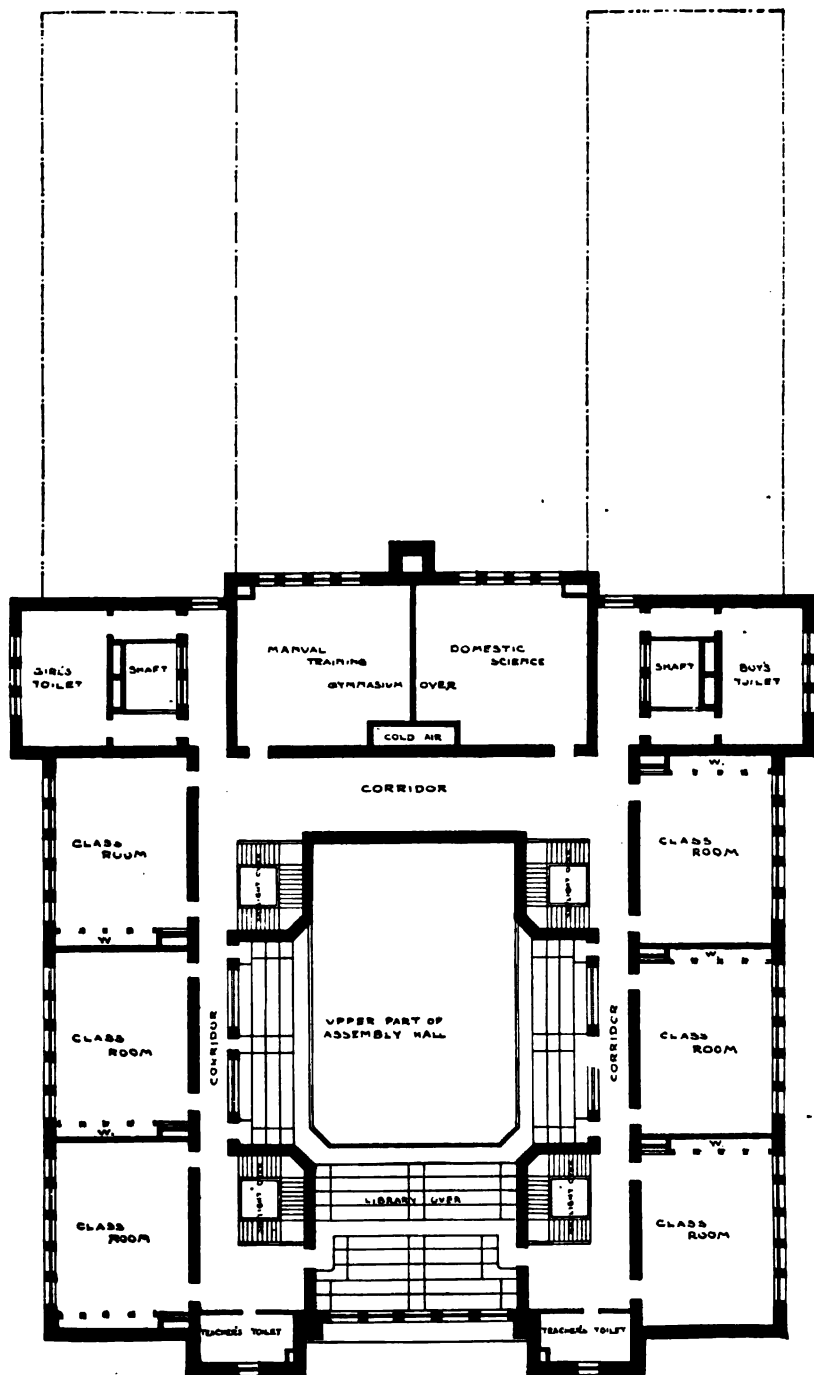
into a restless and careless mood. So the plain advice to give here is, *do not construct your schoolhouse in such a way that windows will open from any class room toward the south*, for it is impossible to light the room properly in this way.

The windows should be placed on one side of the room only, and preferably on the east side in buildings of one room. They should be placed on one side so as to avoid cross lights and prevent the children from writing in the shadows of their own hands. The eyes of any pupil in the room will thus be relieved of the necessity of attempting to adjust themselves to unequal sources of light. Even as simple and as plain a necessity as unilateral lighting for school rooms is not understood by many who know naught of school conditions. A physician recently rebuked me for recommending this method of placing the windows, for he said that he believed it would be a very serious thing to thus compel the children to use only one eye in their work.

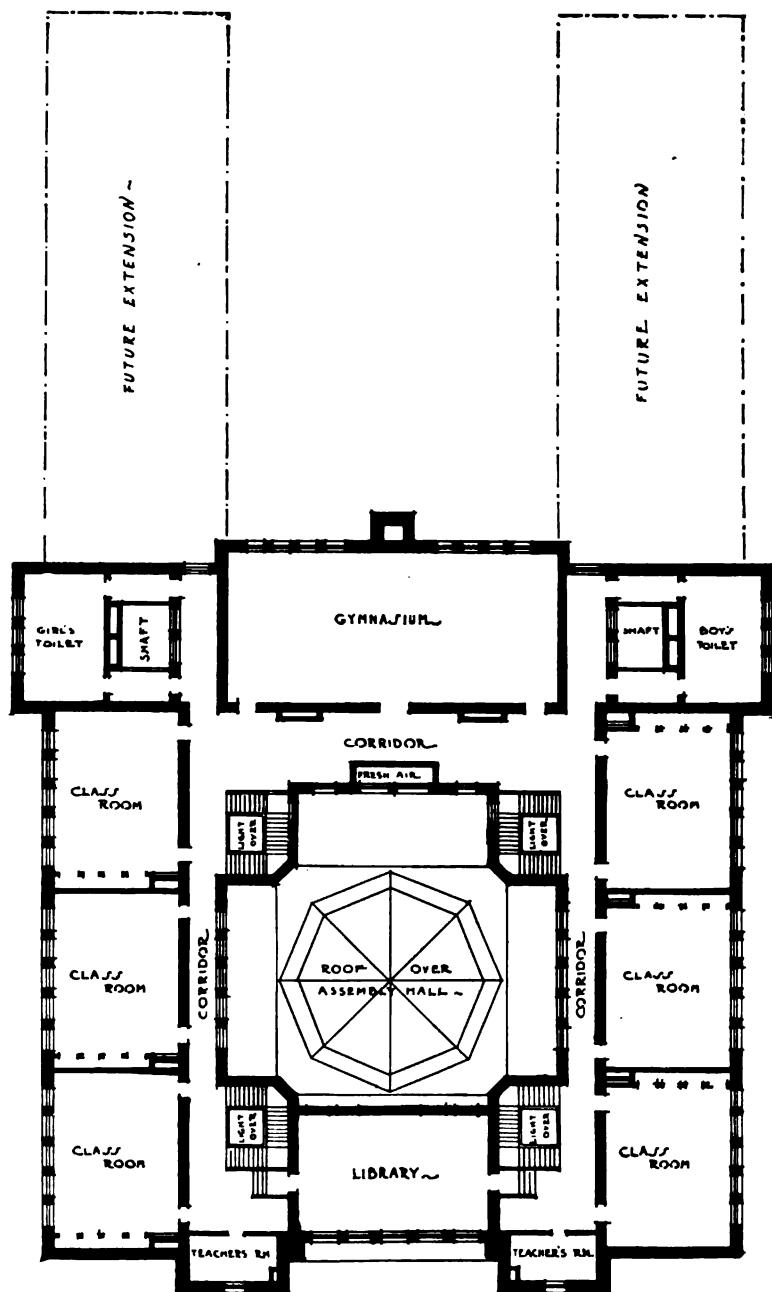
With unilateral lighting it is far easier to arrange for adequate blackboard space and to place it opposite the light, as it should be, than in any method of construction admitting light from both sides. Furthermore, in large buildings it is practically impossible to plan for windows on more than one side on account of the necessary hallways and adjoining rooms.

The windows should be placed as closely together as safety of construction will permit, and well toward the rear of the room—that is, the windows ought to be so located as to be as far as possible to the rear as well as to the left of the pupils when seated at their desks. To make this arrangement of the windows possible, it is necessary to determine, before they are placed, the direction toward which the pupils will face. This will be more easily understood by referring to the drawing showing the proper position of desks and windows. (Fig. 2.) Pupils should receive the light from the left in order that when writing the shadow of the right hand will not fall directly on the point where the pen touches the paper. It follows, therefore, that if there be any pupils who use the left hand in writing or drawing, special provisions should be made for them so that they may sit with the right side to the light. If the majority of pupils were left-handed, plainly the advice should be given to construct the rooms so as to have the windows to the rear and on the right side.

We have said that the windows should be placed on one side only, and preferably toward the east. The last statement in this rule, of course, could not always apply to school buildings containing more than one room. In buildings of two, four, or more rooms, it will often be necessary to have the windows of as many rooms face the west as the east. It still remains true, however, that those rooms whose windows face the east, when other conditions remain the



TILTON SCHOOL, CHICAGO. SECOND-FLOOR PLAN.



TILTON SCHOOL, CHICAGO. THIRD-FLOOR PLAN.

same, will be the most healthful and wholesome rooms because of the early sunning which they will get. And just here is perhaps the best place to say that while the north light is the most diffused and the softest which can be admitted into the schoolroom, it is unsafe to depend on maintaining the health of children kept in schoolrooms with windows looking only toward the north. These rooms will do for art work and laboratories, but not for regular classrooms. Every schoolroom needs a sun bath each day to keep it pure and wholesome, and it is contrary to the simplest and plainest rules of hygiene to construct a schoolhouse which will not permit of this mode of sanitation and disinfection. Also the *first* part of the last rule needs some slight modification in order to prevent it from deterring in certain cases. There are conditions in most of the Southern and Southwestern States, especially in the great valleys, which demand openings toward the north, not for the purpose of getting additional light, but for ventilation and cooling. In the warm valleys, during the early and later months of the school year, the heat is often so intense as to render it almost necessary to get the advantage of a breeze through the room. Under these conditions it is best to have some openings in one end of the room, preferably toward the north. These openings need not be full-sized windows, but better, small windows 8 feet or more above the floor, either hinged to the lower part of the window frame or fastened as transoms. These windows, perhaps two in number, can be covered on the inside with close-fitting opaque shades or curtains, so fastened as not to interfere with freedom in opening and closing the sash. This precaution, together with their height above the floor, will prevent such windows from admitting a blinding light into the eyes of teacher or pupils.

In those sections of our country where there are many cloudy days during the winter and early spring, and especially in smoky cities, with tall buildings not far removed from the school ground, it is necessary, as we have elsewhere said, to plan for at least one-fourth as much glass surface to each room as there is floor space. The difficulty comes in the proper placing of so much glass surface in a single wall. If, for example, the room be 34 feet long, 27 feet wide, and  $13\frac{1}{2}$  feet high, it would be necessary, according to this rule, to place in a wall 34 feet long 229 square feet of window surface. If the bottom of the windows are 4 feet above the floor, and the tops of the windows extend to within 1 foot of the ceiling of the room, the length of the windows would then be limited to  $8\frac{1}{2}$  feet. In order, therefore, to get the amount of window surface demanded by this rule, 27 feet of this wall surface must be glass. This would leave only 7 feet of the wall's length unused. This would not be enough for frames, sash corners, and supports. It would, besides, necessitate the extension of the windows entirely too far to the front, so that

many of the children in a room would be compelled to sit through the day almost facing a window. If, however, the windows are lengthened so as to bring the glass surface within 6 or 8 inches of the ceiling, the requirements for one-fourth as much glass surface as floor space can be met, and at the same time more than 8 feet of the wall space left for corners, mullions, and sashes. But this is scarcely enough, for it would still bring the windows too near the front end of the room.

If we make a similar calculation for a schoolroom of approximately the ideal size and proportion, 24 by 32 by 13½ (this is generally too high), we get far better results, for with these dimensions we can place the windows in one side and still have more than 11 feet of space for corners, sashes, frames, and mullions. This ought to give at least 6 feet of blank wall space in the front of the room, and, while this is not ideal, it is not bad on dark days, and on unusually bright days the shades could be drawn over the front window without risk. It has been advocated by Doctor Harris and others that a part of these required windows be placed in the rear of the room, but near to the window side. This of course would necessitate that two sides of the room have no immediate connection with any other part of the building, a demand which would offer no hindrance in the construction of small buildings, but for large buildings it would introduce insuperable difficulties. Besides, these rear windows would introduce a serious disturbance to the teacher, making it necessary for her to face the light while at work with her classes. But if we calculate on the basis of one-fifth as much glass surface as floor surface, and this is enough for school buildings well situated, we would have 16 feet of the wall left to use for frames, sash, supports, and corners. Hence, under such conditions, there is no necessity for purposes of lighting to put windows in more than one side of school-houses properly placed and where the light is not cut off by fog, smoke, or high-horizon lines.

We have said that the windows should be grouped as closely together as safety of construction will permit. But in the lower rooms of large buildings where strong walls are a necessity there still remains a difficulty. Here the mullions, if made of brick or wood, in order to insure safety, must be thick and heavy, and hence will intercept light, use up wall space, and cast troublesome shadows. Mr. Briggs, of Bridgeport, Conn., has devised and is using in his buildings iron mullions which have a rounded edge both inside and outside the room, and in this way he gets the necessary support, while reducing the shadows to a minimum. This style of mullion in large buildings is a necessity in order to properly place the windows and insure sufficient glass surface. (*Modern American School Buildings*, Warren R. Briggs (Wiley & Son), p. 131.)



PUBLIC SCHOOL, NEW YORK CITY, C. B. J. SNYDER, ARCHITECT. NOTE THE WINDOWS OF THIS BUILDING.



1911

The distance between the floor and the lowest part of all school-room windows should be greater than it is usually made, in order to prevent the light from shining directly into the pupils' eyes. The window sill should be from  $3\frac{1}{2}$  to 4 feet above the floor, so that all light falling upon the desks would come from above the level of the eyes of the pupil when seated at his desk. This is an exceedingly important direction, for, when windows are so constructed, the danger of misplaced and disarranged shade is minimized. Some of the German cities require that the bottoms of the windows must be placed as high above the floor as the top of the pupils' heads when seated. Doctor Lincoln, one of the best authorities on school hygiene in this country, says that 4 feet is none too high.

In order to get the best light and the most of it for the amount of window surface, it is absolutely necessary to run the top of the windows as near to the ceiling as possible; for it is plain that 1 foot of window surface near the ceiling of the room will do more to properly light the room than 2 or 3 feet near the bottom. The tops of the windows ought to be at least 12 feet above the floor, for this will insure sufficient light to those pupils seated farthest from the windows.

Taking the cue from a rather pretty effect in the construction of dwelling houses, architects and school men are beginning to put "coved" ceilings in schoolhouses. In my opinion this is a mistake. I have just measured some of the brackets used to get this effect and have found that, when the laths and plastering have been put on, it necessitates a narrowing of the wall space from floor to ceiling available for windows almost a foot. Add to this the thickness of the frame and the sash and you have the top of the glass surface removed nearly 2 feet from the ceiling. In practice this removal will often amount to fully 2 feet. To make up this lost space, the windows are placed too low in the room or else the ceiling is made too high. But there is no objection to coving the ceiling on all sides save the window side, for the effect is not displeasing, and so far as I can see in no way introduces any difficulty.

As mentioned elsewhere, no pupil should be seated at a greater distance from the windows than that equal to twice the height of the tops of the windows from the floor; and this, too, only on the condition of the proper amount of window surface. Where it is impossible to get sufficient light from ordinary windows, due to errors in plans or to conditions over which builders have no control, the prismatic or ribbed glass now on the market ought to be used. As the result of a series of tests made by Professor Norton at the Massachusetts Institute of Technology, it was found that by the use of this ribbed glass set in the upper parts of windows the illumination of dark rooms

could be increased under certain conditions from 40 to 50 per cent. It is not expensive and can be had in almost any market.

The proper arrangement of shades for the windows is not an easy matter. Blinds, I think, ought not to be used at all, for the reasons spoken of above, and for the further reason that they are far more expensive than common roller shades, and frequently become hard to manage.

The best arrangement of shades to my knowledge which has been devised consists in using two separate sets of shades for each window, both fastened at about two-fifths of the height of the window, the upper one to pull up and the other to pull down. Care must be taken to so place them that they will not rub together when both are rolled up, nor leave a chink through which a stream of light may pass when both are unrolled. Special brackets have been devised for these fastenings and are now on the market. The shades should be wide enough to cover the window and extend over each side of the window frame, to prevent rays of light from passing the sides. This last precaution will save much annoyance later.

There has been a great deal said about the proper color of the shades, and many experiments have been made to find the color and tint most satisfactory to the eyes of children, which will at the same time serve to prevent the entrance of dazzling light. Some have advised the use of an opaque dark green shade below and a translucent lighter green one above. This arrangement, however, can be satisfactory only when the shade used above is sufficiently opaque and sufficiently dark to avoid that peculiar greenish light which makes for discomfort. Rowe, in his excellent little book on "The Lighting of Schoolrooms," says:

I have found that bisque (a light sage) makes a very satisfactory color, not light enough to annoy or dark enough to exclude the light. This and lighter colors of the handmade tint and the Bancroft Sunfrost Hollands meet all the requirements of Cohn's light tester.

Since the light of the room is modified both in amount and quality by the color of the walls, it is in place here to speak of this. What color is best for the walls of a schoolroom? The answer to this question will be given by summarizing a report made to the school board of New York City by a committee of the best known oculists of the city:

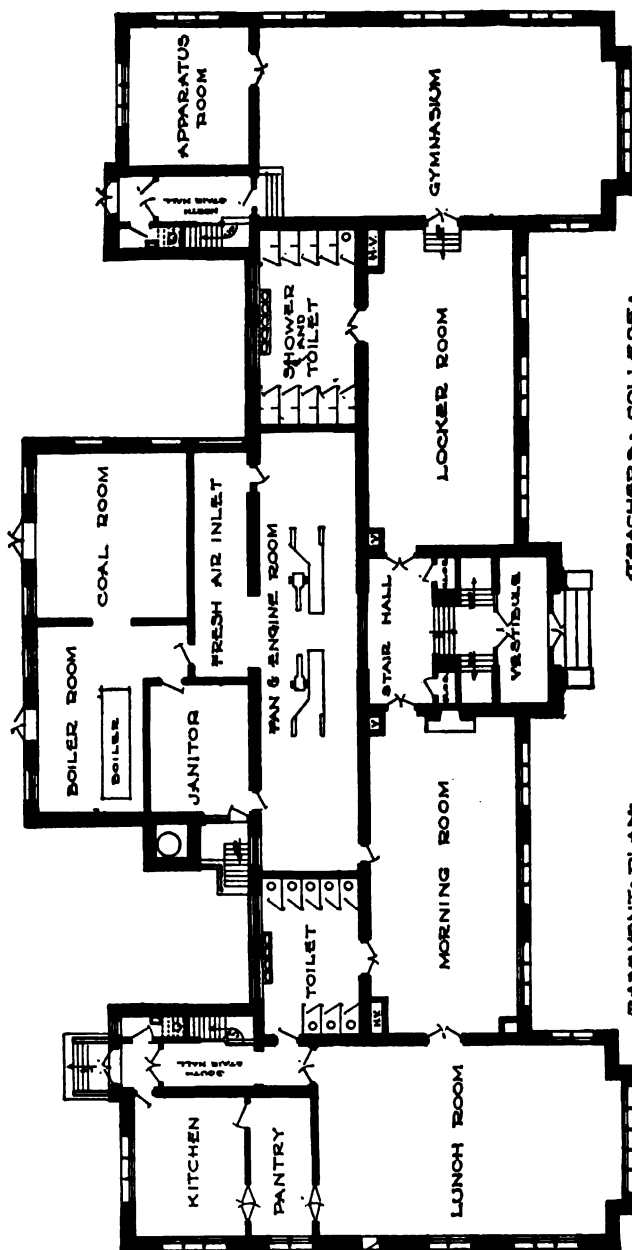
- (1) The wall space between the floor and the window sills and the chalk troughs should be a light brown.

- (2) Side walls and ceilings should be a light buff tint, or a light gray. The red end of the spectrum should never be used in school-room decoration, for it absorbs too much of the light.

- (3) Light-colored wood should be selected for the furnishings and furniture of the room.



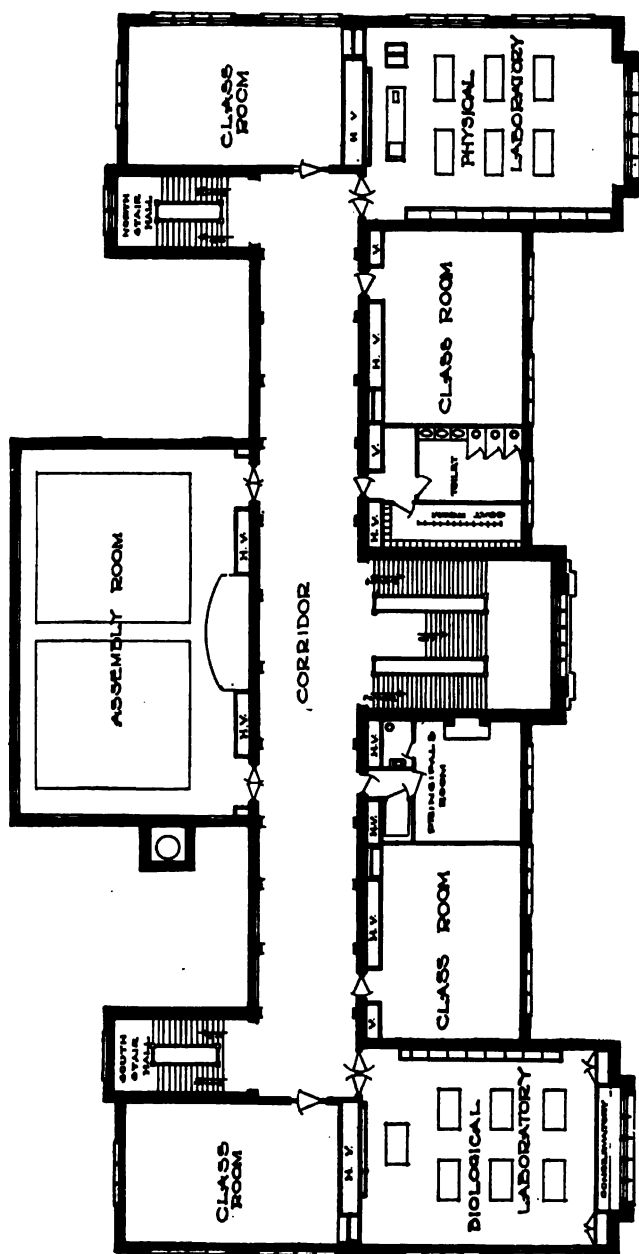
TEACHERS' COLLEGE, ST. LOUIS, MO. WM. B. ITTNER, ARCHITECT. NOTE THE LIGHTING AND THE TREATMENT OF THE GARDEN.



TEACHERS' COLLEGE.  
WM. D. ITTNER, ARCHITECT.

BASMENT PLAN  
SCALE

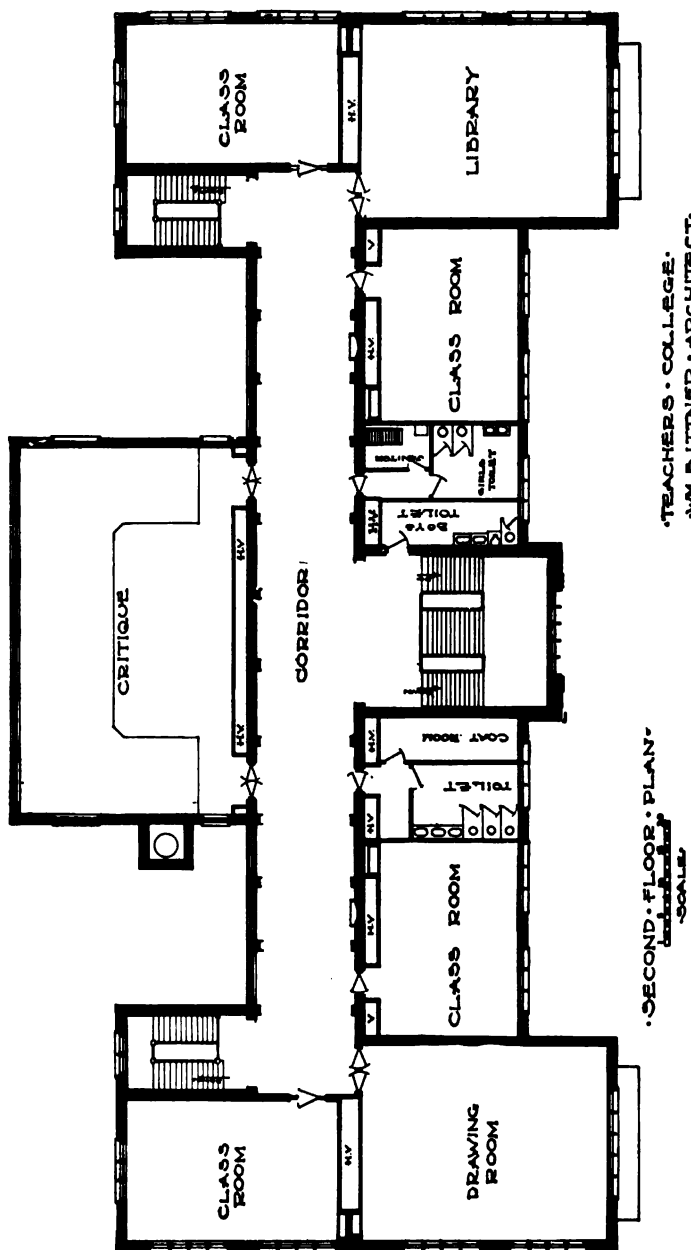
TEACHERS' COLLEGE, ST. LOUIS. BASEMENT PLAN.



•FIRST FLOOR PLAN.  
•SCALE.

•TEACHERS' COLLEGE.  
•W. D. BITTNER ARCHITECT

TEACHERS' COLLEGE, ST. LOUIS. FIRST-FLOOR PLAN.



TEACHERS' COLLEGE.  
WM. B. ITTNER • ARCHITECT.  
TEACHERS' COLLEGE, ST. LOUIS. SECOND-FLOOR PLAN.

(4) The color chosen for the walls and ceilings should be chosen for the most unfavorable days.

(5) The woodwork in the schoolroom should not be highly polished. Natural finish with a dull surface is best.

#### SUMMARY.

1. In those parts of our country far to the north, where the sun is low in the south a greater part of the school year, and in those locations where fogs and cloudy weather prevail or where the air is clouded with smoke, architects ought to allow to each room one-fourth as much glass surface for the purpose of lighting as there is floor surface. In the south and southwest where sunshine is abundant and where the sun is higher above the horizon at noontime, one-sixth as much glass surface as floor surface, when the windows are properly placed, is sufficient. In general, where there are no hills, high buildings, or trees to obstruct the light, and where the atmosphere is comparatively clear, one-fifth as much glass surface as floor surface will suffice.

2. The bottom of the windows should be at least 4 feet above the floor.

3. The windows should be placed as closely together as safety of construction will permit and as far back toward the rear of the room as possible and to the left of the children when seated at their desks.

4. To aid in grouping the windows closely together iron or steel mullions should be used with the inner and outer sides having rounded edges in order that the light from the windows may be equally distributed over the room, that as much light as possible may enter, and that no shadows may fall on the desks near the windows.

5. The windows should extend close to the ceiling, for the best and most effective light comes from the top of the windows and spreads over the entire room most evenly.

6. In case tall buildings or high hills raise the horizon line on the window side of school buildings, prismatic or ribbed glass should be used in the upper part of the windows, for this both scatters and increases the light in darker parts of the schoolroom. This sort of glazing should not be used on the lower part of the windows on account of the glare produced.

7. In hot climates, where during part of the school year a breeze is refreshing and acceptable, there should be placed, when possible, at least two small windows 8 feet above the floor in the end of the room. These windows should be hinged to the lower part of their frames or placed on a pivot and covered with opaque curtains. These windows are not for the purpose of light, but, as suggested, to afford openings for an alleviating breeze when conditions demand.



8. Sliding slat blinds or outside shutters should never be used in schoolrooms either to cut off the direct rays of the sun or for decorative effect, for they are both expensive and ill adapted for school purposes. The best means so far devised and at the same time the cheapest and most easily managed appliances for this purpose are double shades. These should be fastened at a point about two-fifths up the windows from the lower sill. They should be fastened in a specially devised bracket (such brackets are on the market) so that while one shade will close the upper part of the window from below, the other will close the lower part of the window from above. Care should be taken that these brackets are so constructed and so placed that no rays of light can pass between the two shades, either when rolled or unrolled. The shades should be sufficiently wide to prevent the rays of light from entering at their sides.

9. It is a very difficult matter to hit upon the proper color of shades and at the same time to get those sufficiently translucent to allow a maximum of light to pass through without producing a glare. In general, it may be said that a light unobtrusive green seems to be the most satisfactory. This, however, will in part depend upon local conditions and the proper situation of the windows. Green is a very troublesome color to handle in a schoolroom, and tests ought to be made in all cases before final decision is made. For it often happens that a slight variation in shade or the quality of material makes a decided difference in the quality of light in the schoolroom.

10. The great amount of blackboard surface used in American schoolrooms tends to absorb much of the light. On dark days when these are not in use it has been found that great relief can be afforded those children who sit at the desks farthest removed from the windows by drawing down light curtains over the blackboards. Profs. Basquin and Scott report that "by the introduction of screens over the blackboards" they found that in rooms receiving unilateral lighting they could by the use of such screens increase the light at the darkest seat in the room 50 per cent.

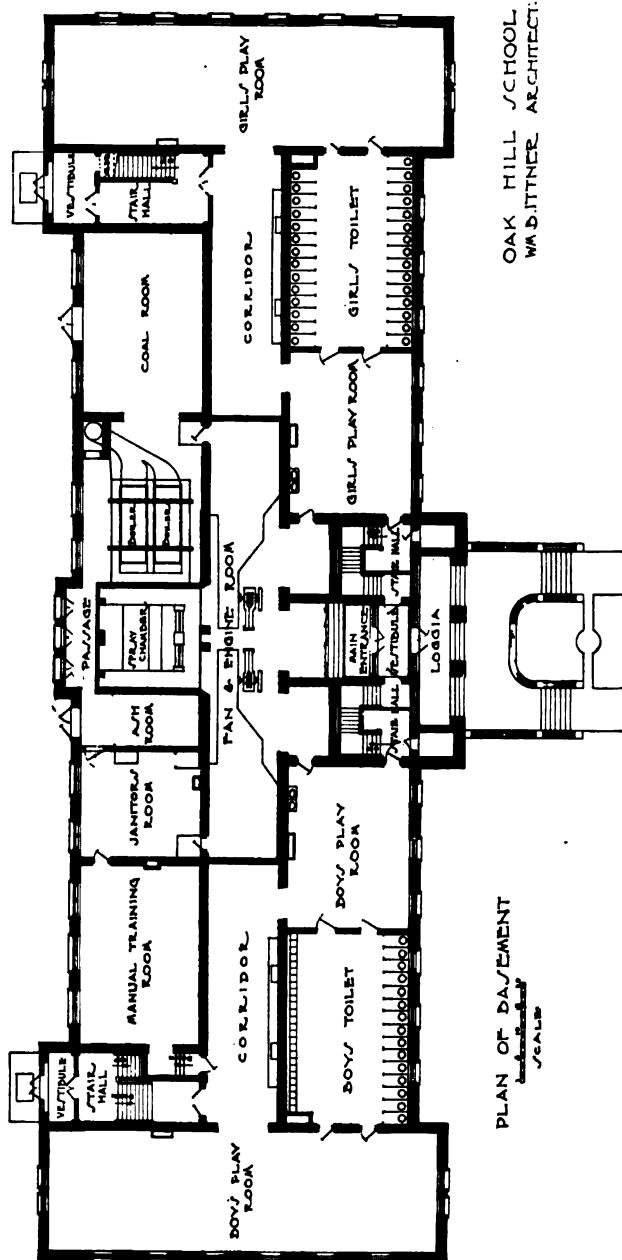
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### HEATING OF SCHOOLROOMS.

Before entering upon a discussion of the various methods employed in heating schoolrooms, it will be well to consider briefly this question: At what temperature should the schoolroom be kept? In England the general opinion is that a temperature of 65° F. at the breathing line is the maximum allowable. On the Continent under similar climatic conditions about the same demands are made. In this country we have generally fixed on 68° to 70° F. as the limit. Just why we insist on higher temperature here is somewhat prob-

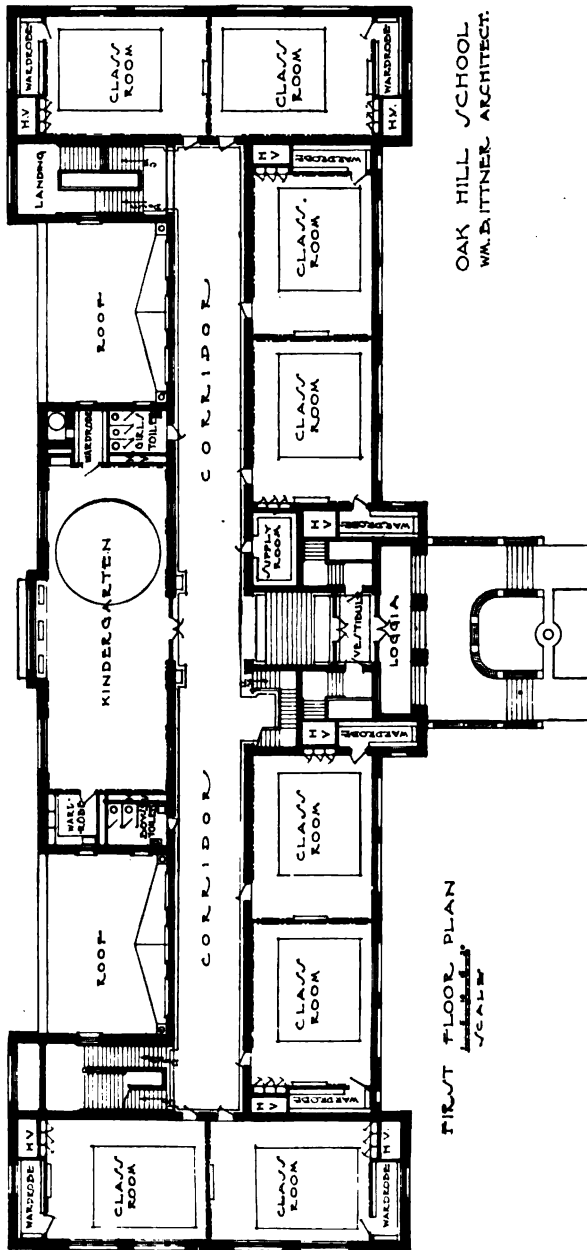


OAK HILL SCHOOL, ST. LOUIS, MO. WM. B. ITTNER, ARCHITECT. STUDY THIS ELEVATION AND THE ACCOMPANYING FLOOR PLANS  
WITH REFERENCE TO THE LIGHTING OF THE HALLS.



OAK HILL SCHOOL  
W. B. ITTNER ARCHTCT.

OAK HILL SCHOOL, ST. LOUIS. BASEMENT PLAN.



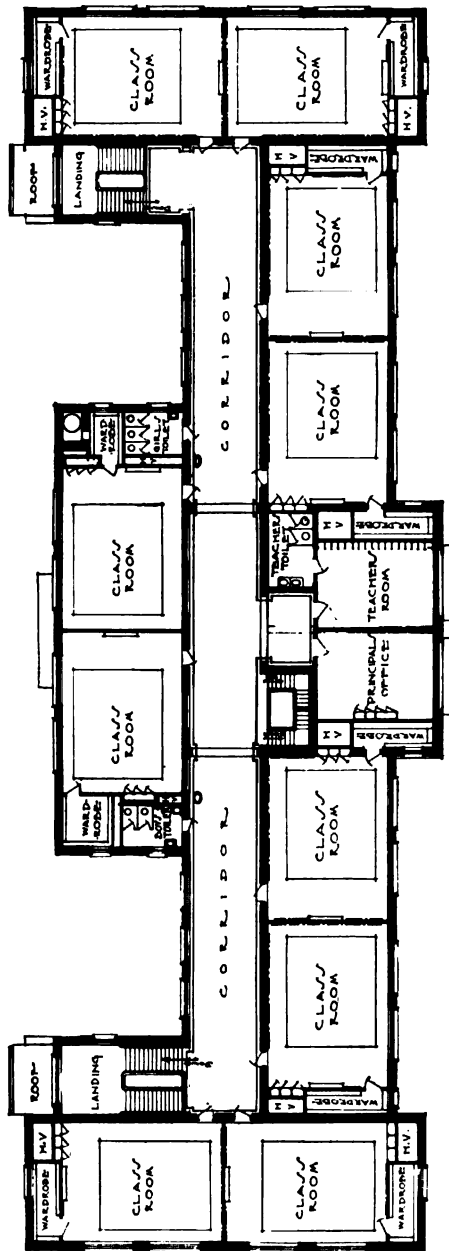
FIRST FLOOR PLAN  
SCALE

OAK HILL SCHOOL  
W. B. ITTNER ARCHTCT.

OAK HILL SCHOOL, ST. LOUIS. FIRST-FLOOR PLAN.

BUREAU OF EDUCATION

BULL. NO. 5, 1910 PL. 46



SECOND FLOOR PLAN  
SCALE

OAK HILL SCHOOL  
W. B. PITTMER ARCHITECT

OAK HILL SCHOOL, ST. LOUIS. SECOND-FLOOR PLAN.

lematical, but I think it can be explained in part at least as a result of habit. Professor Woodbridge's explanation of the demand for higher temperature here than in England is based on the difference between the amounts of aqueous vapor mixed with the air in this country and that in England. He says:

Because water vapor has a higher specific heat than air, a humid air at a lower temperature than the body extracts heat from the body more rapidly than does dry air at the same temperature. On the other hand, evaporation is less rapid in a moist than in a dry air, and the reduction of the evaporation rate results in heat accumulation within the body, notwithstanding the effect of atmospheric moisture in accelerating heat extraction from the body, so long as the air temperature is below that of the body. The process of heat accumulation under such conditions is frequently as much in excess of heat reduction that the resultant effect is a rise in the body's temperature. It then becomes necessary to increase heat elimination through other means by as much as it is reduced by evaporation. Therefore cooler air and cooler surroundings become necessary. That is, as less heat is eliminated by evaporation, more heat must be eliminated by convection and radiation. For this reason the Englishman finds a temperature of 55° or 60° as essential to his comfort as is 65° to 70° for the comfort of the New Englander, who lives in a drier climate, and whose perspiration is more free, and whose heat loss by evaporation is correspondingly greater.

The person acclimated to the English climate suffers from the winter warmth of American houses for the reason that he is constitutionally habituated to a low perspiration rate. When he comes into the New England indoor winter temperature his physiological response to the new conditions is not immediate; heat accumulates, and the uncomfortable and irritating sensation of anteperspiration state is experienced. On the other hand, the New Englander going into English houses finds them cold, for the reason that his higher rate perspiration habit is maintained, and heat loss by that means is at the outset but little reduced, the low temperature and the high humidity of the air, and the low temperature of the surroundings meanwhile increasing the normal rate of heat loss. The Englishman complains of American "ovens." The American complains of English "ice houses." The high temperature of American dwellings is as essential to the American's comfort as is the low temperature of English homes to the Englishman's comfort. (*Air and Its Relation to Vital Energy*, by Prof. S. H. Woodbridge (Mass. Inst. Technol.), *Connecticut School Document* No. 5, 1904, p. 12.)

This seems to me to be the most rational explanation of the general demand in this country for higher temperature in our schoolrooms, and it ought to cause those who strive to set our standards by those found satisfactory in Europe to see that they are running contrary to those principles of hygiene they are striving to follow. However, there are other elements entering into the acquirement of habitual demands for higher temperature here than in England or on the Continent.

Our homes are kept at a higher temperature partly because we have thus far had no urgent need to economize on fuel. Our forests have furnished us wood at small cost and our great coal deposits have supplied a good grade of coal within easy reach of the great majority.

In many parts of Europe the cost of fuel is comparatively high, and greater economy is practiced in this line of expenditure. In the next place many parts of our country are subject to greater variations in temperature in both summer and winter than is often experienced in Germany, France, Italy, or England. That we are more sensitive to cold or at least demand more effective methods of heating is well recognized in Europe as all will be told who go abroad for the winter. Be this as it may, our teachers and pupils insist that the minimum temperature allowable here is about 65° F., and this is equal to the maximum prescribed abroad. While we may find fault with this demand and declare it unhygienic, we must, at present at least keep our schools heated to about 68° F. to avoid complaint from both teachers and pupils. A temperature of 66° F. may be the correct theoretical maximum, and I am inclined to favor this, but it will rarely suffice in practice in many parts of our country. A temperature of 70° at the breathing line was formerly regarded as the ideal to attain, but it is common now to consider it the maximum allowable.

These figures may all be misleading, however, for the construction of the schoolroom and the methods of heat distribution enter vitally into the question. For example, one schoolroom with damp walls and poorly constructed floors may be quite uncomfortable at 68° F. at the breathing line in the center of the room, while another, with damp-proof walls and double floors with deadening felt between may be quite satisfactory with an even temperature of 66° F. One frequent complaint from teachers arises from the fact that there is too much disparity between the temperature at the breathing line for the children while seated and that for the teacher while standing. There is a real difficulty here, and it can be remedied only by double floors well deadened and protected from drafts and more effective methods of evenly distributing the heat. Naturally heated air moving by the force of gravity will seek the upper part of the room, and unless it finds an exit there will remain until it becomes cooler than the ascending currents, when it will slowly descend. If, therefore, there is no effective method for exhausting the air at the floor line and at the same time introducing a little more through the inlets than escapes through the exit ducts so as to allow for leakage, this difficulty will not be overcome. A decided plenum condition is necessary for good distribution. The introduction of abundant warm fresh air by means of a fan, the effective and even distribution of the heat, well-constructed ceilings, double floors, with good insulation and deadening quilt between them, and as rapid movement of the warm fresh air as allowable short of drafts, with all doors and windows closed, are all necessary measures to prevent unevenness of temperature. When all of these regulations are fully met, I am persuaded that the complaints that are heard with reference to unevenness of tempera-

ture can be ascribed to idiosyncrasies, or to the effects of winds over which we can have little direct control.

Every school should be supplied with two or more thermometers, so that the supervisor as well as the teacher may know the exact temperature maintained at the breathing line and at the floor line in all parts of the room. These are not expensive luxuries, but may serve to forestall a good deal of complaint and furnish indisputable evidence for the edification of all concerned.

It will be well to recall in this connection that it has been discovered that certain discomforts which we have hitherto connected with breathing foul air have really been due to working in overheated rooms. Dullness, headaches, and general heaviness of mental action may, and often do, find their immediate causes in this, for heated air has less oxygen bulk for bulk than cooler air.

Next to ventilation and lighting, the temperature of a schoolroom has more to do with school work than any other physical condition. In fact, unless the children are comfortably warmed in cold weather, it is not only impossible to carry on the work of the school, but it is positively dangerous for them to be quiet. It is absolutely essential, then, to make adequate and convenient provisions for heating. This last statement seems to be a useless one, for it is a mere truism; but, sad to say, it is what one might with propriety call a theoretical truism rarely realized in practice.

#### FIREPLACES.

Old-time schoolhouses were heated by fireplaces, and in general those pupils close to the fire were too hot, while those at a distance were uncomfortably cold, for such a fire is more effective in creating drafts in a schoolroom than it is in giving out heat. In a room so heated there is a partial vacuum created, causing the outside cold air to pour in at every possible crack or crevice and to move directly toward the fire. The day of the open fire in the schoolhouse has almost gone, for, while it had some advantages, it failed to accomplish satisfactorily and economically its purpose. It was cheery on mild days and totally inadequate on cold days, but it was a good ventilator—indeed, too good. In comparatively recent years fireplaces have been constructed in such a way as to warm the fresh air and introduce it into the schoolroom through ducts above the fireplace. This style has a distinct advantage over the original in that it helps in preventing drafts and at the same time is more economical of fuel. But fireplaces in school buildings are inadequate and ineffective save in well-constructed buildings in mild climates. Even so, the trouble of keeping up the fires and preparing the wood is too great to commend them for use in a busy schoolroom. Most fireplaces and grates



waste more than 90 per cent of the fuel. As an auxiliary to ventilation, when the heat supply comes from a furnace or through steam coils connected with the fresh-air inlets, the fireplace correctly placed is useful and effective.

#### BOX STOVES.

The box stove came next with its greater efficiency and economy. It heated the room but afforded no effective means of equalizing the temperature in the various parts of the room. When situated in the center of the room it was in the way, and because of the fact that it was out of the question for a pupil to sit near it when it was heated sufficiently to meet the demands of those occupying benches next the walls much of the best space of the schoolroom was wasted. If placed near the end or side of the room it was ineffective for the room as a whole. The roastings to which the school boys of a generation ago were subjected remain yet as vivid impressions. Fortunately, vigorous outdoor employments and sports, together with short school terms, minimized the dangers. In early days the school buildings were often built in such a way that the wind swept under the floor at will. Double floors with deadening felt were not known, or if they were, knowledge in this case at least had no relation to virtue. Single floors with open cracks were the rule. The walls were made of studding, covered on the outside with one thickness of clapboards put on shingle fashion, and on the inside with wide boards tongued and grooved. Shrinkage was ample and hence the stove must be kept red hot in cold weather. Log houses well chinked were in some respects much better, but awkwardly fitting windows in these generally evened up the difficulties.

The great majority of the country schools in parts of our country are yet in the box-stove era, but the buildings are being more carefully made, and hence the children are somewhat better protected from the cold.

#### JACKETED STOVES.

The jacketed stove is the next step in the evolution of the means of heating school buildings. A jacketed stove, as its name indicates, is a stove surrounded with a casing or jacket, between which jacket and the stove there is left an air space connected directly by means of one or two ducts with the air outside. These ducts permit the cold fresh air from the outside to come in contact with the stove and when it is warmed to rise directly into the schoolroom. The jacket when properly fitted serves to keep this fresh air close enough to the stove to warm it, and at the same time to deliver it into the room well above the breathing line. It is well to provide the fresh-air inlets with dampers to be used during troublesome winds.

To get the best results with stoves of this sort, it is necessary to have an exit flue or duct through which the vitiated air of the room can be drawn out. A simple and rather effective way to do this is to make the smoke flue large enough to inclose the stovepipe from the stove through almost to the upper air and still have room around it for the exit of the vitiated air. In small buildings this exit duct can be made by extending the flue to the floor and opening it in a small fire-place. This opening should be at least 3 feet high, so that drafts toward it would not be merely at the floor line, but more evenly distributed between the floor and the breathing line. There should be a close-fitting cover provided for this opening, for it is advisable to close it at nights to prevent soot or sooty odors from being drawn into the schoolroom with the descending currents of cold air. The stovepipe may enter the flue about 8 feet above the floor and be continued to almost the top of the chimney. The fire in the stove will heat the pipe within the flue and thereby, through radiation, cause an upward current of air directly from the lower part of the schoolroom. This will have the effect of exhausting the air at and below the breathing line, and also aid in causing the heated air emerging from the jacket to circulate more freely throughout the room. In case this circulation is not sufficiently active, especially in mild weather, to equalize the temperature of the room, a fire built in this fireplace will help materially. The accompanying drawing (Fig. 11) is designed to illustrate this arrangement.

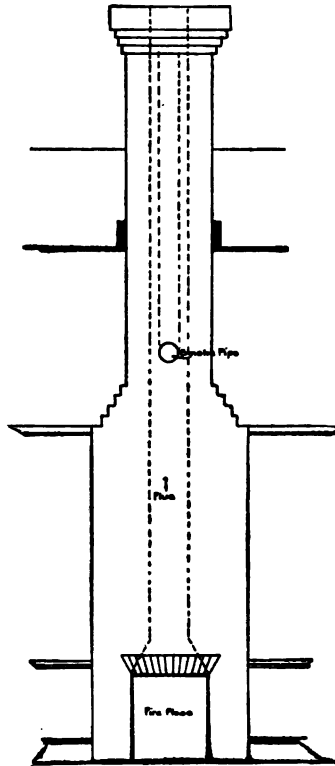


FIG. 11.—Exhaust flue and small fireplace for use with a jacketed stove.

A jacketed stove can not be trusted to ventilate a schoolroom effectively at any time and not even passably save in very cold weather, and then only on the conditions that the building is well constructed, that the stove is large, that proper means for exhausting the air are used, and that the air ducts for the entrance of the fresh air are sufficiently large not to hinder through much friction. For a crowded school it is never sufficient.

It is better for several reasons to locate this stove near a corner of the room. This will render long ducts unnecessary and require a short length of stovepipe within the room. Such stoves as here described are now on the market and are much to be preferred to the unjacketed stove. But it is false economy to stint in the size of this stove for two reasons. A large stove will afford better ventilation by introducing more fresh warm air, and hence cause a more rapid change in the room which in turn will secure a more even distribution of the heat; it will also make it unnecessary to heat the air to such a degree as to make it dry and harsh, and it is more economical of fuel.

#### HOT-AIR FURNACES.

In large buildings the idea of the jacketed stove is realized in the so-called hot-air furnace system of heating. A hot-air furnace is nothing more than a modified jacketed stove. Either the heat is supplied directly through radiation from the fire box and its system of radiator or from steam coils incased in a jacket or warming chambers. In both cases the jacket completely surrounds the radiating surfaces save at the points where the fresh air enters and where it is discharged through ducts into the schoolrooms. A hot-air furnace so constructed as to utilize economically the fuel furnishes a ready and convenient way of heating dwellings, schools, and public buildings generally. There are nevertheless some serious objections and difficulties encountered in the use of this method of heating which ought to have careful consideration.

There is danger that the gases produced through combustion, especially of coal or oil, will leak through the joints in the furnace and enter the air passing into the schoolrooms. The danger is especially marked when through carelessness of the janitor or the person who tends the fires the furnaces are overheated and then somewhat suddenly allowed to cool by opening the doors of the fire boxes. In cold weather when it is necessary to heat the radiating surfaces very hot to supply enough heat in the rooms the danger is more marked. It must ever be remembered that however tight the joints are made in the beginning, any furnace radiator is subject to great strain through the expansions due to heating and the contractions due to cooling. These strains will in time open the joints and furnish opportunity for some of the carbon monoxide and sulphurous gases generated by a coal fire to escape into the air ascending to the rooms. The only remedy for such a defect is to make the radiators so large that it will be unnecessary to make them very hot to raise the amount of air needed to the temperature required. It is obvious, then, that an overworked furnace is the most dangerous furnace when leakage of gases is considered, and the most expensive in the cost of fuel.

The practical lesson to learn here is this: If a furnace is to be used for heating the air and delivering it to the schoolroom, it is essential to install one abundantly large, so as to heat all the air needed without the necessity of overheating the radiators. It is in no sense an exaggeration to assert that 75 per cent of the furnaces for heating schools I have examined are too small for either safety, economy, or health.

In large buildings where this method is used, it is good economy to have two or more furnaces in different parts of the basement and to adjust the fires accordingly. This plan of separate furnaces has the double advantage of preventing overheating and of making it much easier to introduce the air into the rooms without serious friction in the ducts and with a minimum loss of heat through radiation. For, long air ducts, especially where there is much horizontal run, offer so much friction to the passage of the air through them and afford an opportunity for so much loss of heat that they are almost useless when depending on gravity for air movement; and even when a fan is used they are still ineffective.

When cold air comes in contact with overheated radiating surfaces it becomes dry and, as it were, parched. Such air is in effect desert air, and when introduced into a schoolroom will rapidly absorb moisture from the skin and especially from the lining membranes of the eyes and air passages. Such continual absorption renders the skin and more specially the mucous membranes of the eyes, nose, throat, and trachea dry and harsh. Such a condition, as everyone ought to know, offers ideal opportunity for pathogenic germs to lay hold of these delicate tissues and penetrate into their crypts. When the lining membranes of the air passages are coated with their normal moisture or mucus, it not only serves to prevent these germs from so readily reaching the tissues, but it also catches dust particles and thereby prevents them from being drawn into the lungs. After a ride in dust and smoke, the condition of the lining membranes of the nostrils will bear witness to this fact. Besides, it seems quite probable, if not certain, that these mucus exudations may have germicidal properties which have hitherto escaped scientific detection.

All hot-air furnaces should be supplied with some means of moistening the air before it is introduced into the schoolroom. Especially is this necessary in cold climates where the amount of moisture mixed with the air is necessarily small and where its temperature must be raised 40° or 50° F. The expansion of the air thus taking place will further reduce the percentage of saturation very greatly, and serious and annoying dryness will result; and then we have a desert atmosphere in the schoolroom. The problem of heating is intimately connected with the problem of securing satisfactory humidity in the air.

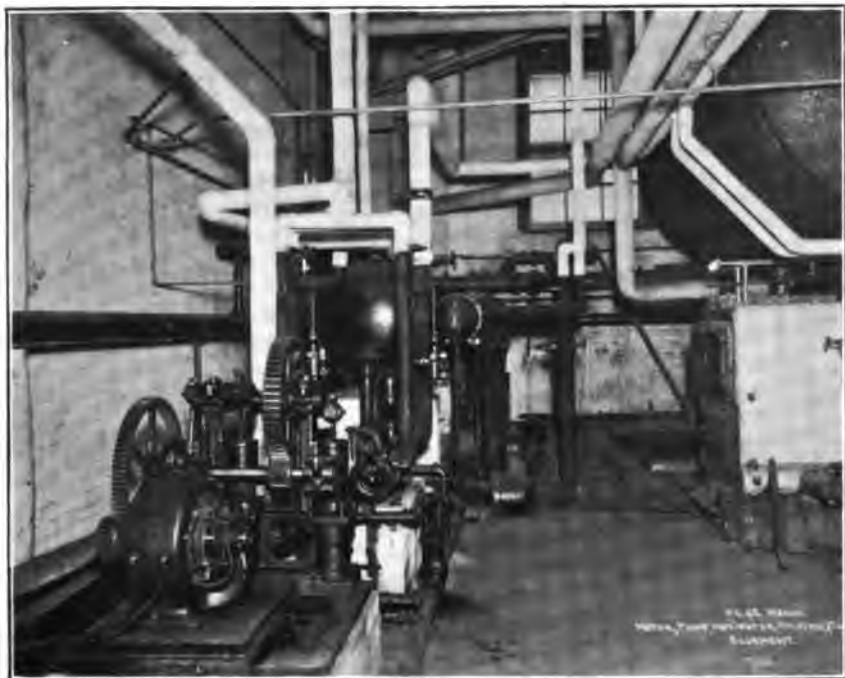
Obviously, the supply of fresh air to the radiator surface of a hot-air furnace or, for that matter, to any heating surface used should enter through a clean passageway and from a point well above the ground. The walls of the passageway and the fresh-air chamber near the furnaces should be carefully constructed of glazed brick or lined with smooth, hard cement, in order that as little friction as possible will result as the air passes to the heating surfaces. The floors of these air passages should be cemented and kept scrupulously clean, for any dirt or dust that enters them will quickly find its way into the schoolrooms.

If the opening for the entrance of fresh air is placed 6 or 8 feet from the ground there is much less likelihood that dust from the playground, the roadway, or street, or contaminated ground air will be drawn into the schoolrooms. This opening should be securely screened so as to keep out the larger particles floating in the air during high winds, and to prevent anything from being thrown into it, such as apple cores, orange peels, or anything else that would vitiate the air or litter the floor. These passages must be carefully closed below and as far as possible made air-tight so that foul air may not be drawn into them from the basement. The location of the opening to receive the ingoing fresh air is a matter of much importance on account of the influence of winds, the danger from dust, and the need of drawing the air from the purest source possible. It has been found that if this air can be drawn from the south or warm side of a building there will be a decided saving in fuel. Carpenter says:

It may be demonstrated by a properly protected thermometer that the average day temperature of air is higher on the south than on the north side of a building. The difference often reaches 10° F. An average of 5° F. would make it highly advantageous to take the air from the south rather than from the north side of a building. If an average rise of 35° F. is needed in the air temperature in ventilating work, then one-seventh of the heat required for that rise could be gained by choosing a south as against a north location for the inlet. (Heating and Ventilating Buildings, Dr. Rollo C. Carpenter, p. 451-452.)

The fresh air must be brought into the bottom of the heating chamber so that even on windy days there will be no possibility for reverse currents, and that at all times there will be as little hindrance to the easy movement of the air as possible.

All things considered, and especially when a furnace of ample radiating surface is installed, when the ducts leading to the rooms are mathematically proportioned and not too long, and when proper means are afforded for moistening the air to the hygienic degree of saturation, there seems at present to be no system of heating better suited to small and medium sized school buildings than the hot-air furnace. There is no complicated machinery to handle, as in steam heating, and the problems of plumbing and repairs are reduced to a



A. MOTOR, PUMP, AND WATER HEATER IN THE BASEMENT OF PUBLIC SCHOOL NO. 62, NEW YORK CITY.



B. VENTILATING FAN AND ENGINE IN THE BASEMENT OF PUBLIC SCHOOL NO. 37, NEW YORK CITY.



minimum. Time is saved in the mornings, for a hot-air furnace responds with heat more quickly than steam, and very much more quickly than a hot-water system. The one serious defect in a hot-air furnace, as has been mentioned, is the danger of contaminating the air through leakage of gases. Steam and hot water coils are in the main entirely free from this defect.

It is unnecessary to state or discuss in this treatise the various rules used for determining the exact amount of radiating surface needed to easily and safely meet the demands to be made on any system of heating. These are matters for the expert engineer to determine, and a school board will act wisely when it seeks and pays for such advice. This caution, however, ought to be given: Some expert engineers—indeed, many of them—know little about the demands of schools, and it is always better to select for consultation one who has made a careful study of the peculiar needs of schoolroom heating, and especially one who has no connection with manufacturers of heating systems. One duty, and a very important duty indeed, which such an expert adviser ought to be called on to perform, is to test the plant when completed and be sure it fulfills the contract signed.

#### STEAM HEATING.

The most generally used method for heating large office buildings and apartment houses is that of employing direct radiation from steam coils or radiators located in the rooms to be heated. But it is manifestly clear that this method alone will not satisfy the demands of school buildings, for there the heating and ventilating can not be separated. In heating by steam all the radiators may be placed in the schoolroom or in a warming room in the basement, or else a part of them in the room and a part in a heating chamber in the basement. When all the heating is to be done directly, the fresh air brought into the room will have to be heated after it enters. Evidently this method will make it difficult to supply a sufficient amount of fresh air without danger from drafts. It will also introduce another difficulty. It will necessitate several entrance ducts leading to the various sets of coils required in the room. Where the gravity system is used the custom has been to locate these coils in recesses in the outside wall, receiving the fresh air about them through openings directly to the outside air. This method for cold climates is simple and fairly effective for heating purposes. But it makes it exceedingly difficult to maintain an even circulation of the air, for, as we have said elsewhere, exit ducts must be on the same side of the room as the entrance ducts in order to insure evenness in temperature. Exit ducts in the outer walls are very ineffective unless they are heated, and even then are both uncertain and uneconomical. It is therefore risky in the extreme to



depend on this method to supply both heat and proper ventilation. On the other hand, if the fresh air is partly warmed in the basement by circulating through a series of steam coils inclosed in a jacket, and is driven into the rooms by a fan, as in the case of a hot-air furnace, circulation can be maintained. If in addition auxiliary coils are placed in the room, say in the front and back outer corners, the objections just urged will not hold.

But steam radiators placed in the schoolroom are often disconcertingly noisy. The hammering or slapping sounds which are not infrequently heard are very annoying and distracting alike to the teacher and the pupils. So far as I know there has been no way devised to get rid entirely of these disturbances, for they seem to be caused by the rising steam catching and driving back the returning stream of water produced by the condensation of the steam already used. In addition to this noise in any system of steam coils, the valves get leaky and the escaping steam will set up confusion, or the dripping water will injure the building.

All of the so-called vacuum systems of steam heating are designed to prevent this noise, and in addition to so manage the steam supply in the radiators that the temperature will be automatically regulated. But those systems of this type, which I have seen in use and for which large claims have been made, are not free from beating noises, nor will they properly regulate the temperature. Theoretically, they may be all that they claim, and if perfectly set and furnished may suffice in practice; but I am told by a distinguished engineer that thus far there is surely a discrepancy between the claims made for these systems and their practical workings.

In the ordinary systems of steam heating, it is difficult to regulate the heat unless the radiators are so arranged that one can be cut off without affecting others. But more serious still for schools is the fact that with steam coils the heat in each room must in a measure be regulated by the teacher. True, when the air is partly heated by passing over coils in the basement by a system of thermostats, the temperature of the incoming air can be increased or diminished automatically. Still, where the radiators are in the room, the teacher will often have to regulate the supply of steam by means of the valves. These are often hot, hard to turn, and frequently forgotten or adjusted irregularly. Here is afforded an opportunity, as anyone acquainted with the busy hours of a teacher's day can see, for serious danger through irregular and unsteady heating. Teachers can not be trusted to handle such a method satisfactorily. In order to be efficient in cold weather, the number and size of the coils must be made to satisfy the maximum demands which will be made upon them. Hence in mild weather the room will be overheated, or else much waste of fuel will result. For when steam is circulating in radiators

they will approximate the temperature of live steam regardless of the outside temperature.

Instead of locating the main heating coils in one plenum chamber and driving the air over the whole battery of coils and through the connecting ducts to the rooms, small plenum chambers with ample supply of steam coils can be made and placed at the base of each separate duct. The heat from each coil will then, minus the radiation, of necessity find its way into the room for which it was designed. The fan will thus be aided in each duct by the force of gravity and the heating surface can be proportioned to the varying demands of each room. A mixing damper in these small chambers connected with a thermostat in the room will serve to effectively regulate or temper the air should it reach too high a temperature. An arrangement essentially similar to this has been designed by Lewis and put into operation by him. From an article describing his methods and the results obtained, I quote the following:

In this new type the boilers are set so that the difference in level between the base of the blast coils and the boiler water line is about 30 inches; and the coils are located in small plenum chambers at the bases of the flues. The air is tempered for cooling the rooms by double dampers in the plenum chamber decks. When the fan is stopped the rooms get a good flow of air by gravity, and are heated almost as efficiently as by direct radiation, while securing considerable ventilation. \* \* \* The steam filling is a little more expensive than with the first type (steam coils all close to the fan), but infinitely less expensive than with auxiliary direct radiation. (*Engineering Record*, vol. 58, No. 8, p. 146.)

Therefore in very large school buildings, where one central heating plant must be installed to supply the whole building, a far more even distribution of heat can be maintained by using some such method as that indicated. By this means steam can be piped to various parts of a basement and expanded into radiators over which fans can drive the air into the rooms directly above, thereby preventing friction and loss of heat and insuring a more even temperature.

Steam heating is better adapted to cold climates than it is to those parts of our country where mild to medium weather prevails through the greater part of the winter season. Chicago, St. Paul, and the interior cities of the North and Northwest find steam heating even with all its troubles and dangers best adapted to school buildings in severe weather.

Steam-heating apparatus requires more care and gets out of order much oftener than any other system now in general use, save, perhaps, that for hot water. This is due to the fact that the radiators, of which a great number is required, are often quickly heated and as quickly cooled; thus by rapid expansion and contraction joints are opened, and these are very hard to close. Besides, the boiler requires expert care in order to minimize the danger incident to the use of

confined steam and to guard against deterioration through the accumulation of sediment and precipitations. Leaking flues and steam fittings require the services of expert mechanics, and this is expensive service.

#### HOT-WATER HEATING.

In the main what has been said concerning the difficulties with a system of steam heating will apply to hot-water heating. One distinct advantage of a hot-water system over steam is that it is more satisfactory in mild weather, for in order to secure a circulation of water in the pipes it is not necessary to heat it to as high a temperature as would be required to supply sufficient heat in cold weather. This would not only serve to economize in fuel, but would make it possible for the janitor to do a large part of the regulation of the temperature in the rooms by means of the intelligent adjustment of fires. Another advantage lies in the fact that hot water gives a more regular supply of heat and generally of a more acceptable quality than either steam or a hot-air furnace. But it is a slow method, and for climates subject to sudden and decided fluctuations in temperature is very unsatisfactory. There are some disadvantages as compared to steam occasionally overlooked. It seems to require better joints to avoid leakage than does steam, and this may mean much trouble. By reason, too, of a slower rate of circulation, due to lack of central pressure, there is more danger of unequal distribution of the heat. This, however, can be overcome to some degree by proper grades.

There are some general advantages in the use of steam and hot-water systems of heating that ought to be mentioned. Perhaps the greatest of these is the fact that a large building, even a series of them, can be heated from boilers located in one place, and if conditions require it outside the main building. This will save room in basements, remove the dust and dirt of the fuel from the school building, and decrease the danger of fires. By carefully insulating and inclosing the feed pipes the loss of heat by radiation need not be very great, and the heat can be fairly equalized throughout the building.

Speaking in general terms, a hot-water system is not well adapted for the heating of school buildings, and unless there are special reasons, due to local conditions, for installing such a plant, experience and the reasons given above advise against its use. But should local demands and conditions favor its use, a competent engineer is needed for making exact calculations and for guidance in the location of all its parts, for as Doctor Billings says:

The technical difficulties to be overcome are greater in the case of hot-water than of steam apparatus, and require greater care in proportioning areas of pipes and openings, in maintaining proper grades, etc., in order to secure the requisite amount of circulation in every part of the apparatus. (*Heating and Ventilation*, Dr. J. S. Billings, p. 240.)

## THERMOSTATS.

In order to regulate automatically the temperature of the air to be supplied to the schoolroom, and thereby to regulate the temperature of the room, many devices have been patented in the last 10 or 15 years. All of these must of necessity depend in one way or another upon the principle of expansion by heat and contraction by cold. The practical difficulty to overcome has been that of hitting upon a medium sufficiently sensitive to respond and yet steady enough to prevent rapid fluctuations. Some use mercury as the medium, others sensitive metals of a more rigid form, and still others liquids of such a composition that they will vaporize at the temperature required. Generally those using mercury depend on making and breaking an electric circuit in which an electromagnet acts upon the dampers to close or open the entrance for hot air, and vice versa to open or close the duct permitting the entrance of cold or tempered air. Those using liquids depend directly upon the force generated by the vapor to regulate the dampers, while those using metals of a rigid sort depend upon the management of compressed air to do the work required. These appliances have brought great relief to both the teachers and the children, for without them the teacher was compelled to keep watch on the thermometer to prevent the room from either becoming too cold or too hot. When thermostats are properly installed and the heating is of the indirect sort mentioned, the temperature of a schoolroom can be regulated, and, if the heat is always to be had, will keep the room at a temperature not varying more than 2° F. at any time. One of the most successful kind within the limits of my experience may be described briefly as follows: Somewhere in a convenient place in the basement is a tank containing compressed air, from which small pipes radiate to the various schoolrooms, where they connect with a thermostat properly located and carefully adjusted. One part of the apparatus visible in the schoolroom shows by means of a pointer whether the room is being cooled or warmed. A neat covering containing a thermometer shields the rest of the apparatus and at the same time furnishes a ready means for testing its accuracy. The thermometer has no organic connection with the thermostat. The air is supplied to the tank containing the compressed air by an air pump automatically regulated. The force applied to this pump is usually that of the water in the pipes of an ordinary city water supply. If this is not available, some other source of regular power must be used. If the temperature of the room is below that required, the opening in the end of this tube is kept closed by a tight-fitting valve or plug held in place by a spring. When the air reaches the temperature desired, a tongue of specially prepared metal expands, and, by means

of the mechanism connected with it, opens the valve and permits the air to escape through another tube, at the end of which is a small air-tight chamber covered on one side with a rubber diaphragm. These are in the basement, where the changes in the diaphragm can be observed by the fireman. The pressure of the air within this cavity forces up this diaphragm, which acts on a lever connected with the dampers in the air ducts leading to the schoolroom, and thus cuts off a part or all of the warm air and at the same time opens the damper to the cold-air chamber, and thus through the pressure of the fan allows the cold or tempered air to be driven into the schoolroom until that temperature is reached which causes the metal tongue to contract. The spring will then cause the valve to close the tube leading to the compressed-air tank and at the same time permit the air in the diaphragm to escape back through the tube into the outer air. The diaphragm will then be compressed by a spring attached to it and the dampers will be reversed, allowing warm air again to enter the schoolroom. This plan will prove successful if carefully guarded, and the apparatus is so made that it will not be constantly changing and through too great a range of temperature. It is claimed by the company manufacturing it that it will regulate the temperature to a range of  $1^{\circ}$ .

There is this to be said about all thermostats with which I have had experience in school buildings: They are complicated bits of apparatus and must be guarded with care and will not prove successful unless the caretaker thoroughly understands their construction and knows how to adjust them. It is a waste of money and dangerous to the health and comfort of school children to install a system of thermostats and then to put them under the control and supervision of a janitor or a teacher who does not understand the principle used in their construction or the mechanism devised to utilize the principle involved. A janitor selected for political purposes or simply because he can sweep and build fires is never likely to handle them well. Here, then, let me repeat what is said elsewhere, the janitor of a modern and thoroughly equipped school building must have had a good deal of mechanical training and above all must be a man of high-grade intelligence.

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### VENTILATION.

It would require the writing of a volume to discuss exhaustively the problems connected with ventilation, and even then lack of exact knowledge would be much in evidence, for there are still many unsolved problems in this field. It seems wise then to limit the discussion in this bulletin to those demands which must be considered

and met during the process of the construction of school buildings and leave the others to more technical treatises on school hygiene and engineering. Let us then set ourselves the task of answering as best we can this question: What are the requirements in the way of equipment and construction necessary to secure adequate ventilation of a modern school building? There has been devised no satisfactory system of ventilation for school buildings which does not use some mechanical means to drive the air in as it is needed. The gravity system of ventilation can be made fairly satisfactory in very cold weather only, when the difference between the temperature required in the room and that prevailing outside is  $40^{\circ}$  or  $50^{\circ}$  F.; but in mild or warm weather no gravity system will afford anything like satisfactory ventilation. The reason that this is true lies in the physical principle that all air motion necessary in gravity or natural ventilation is caused by the difference in weight of the same bulk of heated and cold air. When we warm the air it expands and so becomes lighter, and hence will rise when surrounded by colder air, for the same reason that a cork will come to the surface if immersed in a bucket of water. Water is heavier than the cork and will thus displace it until it finds a balance at the surface where a part of it will extend above the water. Cold air is heavier than warm air and will displace it if opportunity is given for the warm air to rise. Now, if the air outside a schoolroom is cold and the air inside is heated either by direct or indirect radiation, there will be a pressure exerted from all sides and underneath the schoolroom by the heavier, that is the colder air, to displace the warm air and drive it up just as the cork is driven up from the bottom of the pail of water. The cork does not come up of itself, neither does the warm air rise of its own accord. Neither would move were it not for the fact that there is less friction to overcome in the falling of a small body of a given weight than there is of a larger body of the same weight. This gives us the principle upon which all forms of natural or gravity systems of ventilation depend. Remember that when air is heated it expands, hence bulk for bulk is lighter than cold air. Suppose then it is cold weather and we depend on heating the air about a furnace or steam coils in a basement and connect these heating boxes by means of a system of ducts with the various schoolrooms above. As the air is warmed it expands, becomes lighter, and is forced to rise by the greater weight of the same bulk of cold air which will rush into the duct leading from the outside to the heating surface, providing of course this entrance duct delivers the cold air *underneath* the heating surfaces and the ducts leading to the schoolrooms connect at or near the *top* of the heating chamber. Suppose the air outside is at a temperature of  $20^{\circ}$  F. and the fires warm the heating surfaces in the furnace so as to cause this cold air to take a temperature of  $70^{\circ}$  F.

There will then be a strong upward movement of this heated air caused by the pressure of the cold air. This warm air will escape through the ducts arranged for the purpose into the schoolrooms. This warm air is pure air, if it comes from a good source, and if the heating surfaces are properly made, and hence the schoolrooms are being supplied with pure warm air. But it is plain from what has been said that the amount of such fresh air delivered into the schoolrooms will depend on the size of the ducts and the rate of the movement of this fresh warm air. Try another experiment with the cork by embedding in it some leaden pellets, such as shot, to see if the rate of its movement from the bottom of the bucket to the surface of the water will be increased or decreased. You know what the result will be before trying. The less the difference in weight between the cork so loaded and the same bulk of water the slower will be its upward movement. Exactly the same thing happens by reducing the difference in weight (that is, the amount of expansion) between the air ready to enter the schoolroom and that outside. Suppose, for example, the air outside is at a temperature of  $50^{\circ}$  F. To heat it to a temperature of  $68^{\circ}$  F. will cause less difference in expansion and therefore less difference in weight. Hence the rate of movement will be slower and less warm fresh air will enter a room within a given time. Thus the ventilation of that room will be less rapid and will supply the needs of fewer people.

Children of the primary grades gathered in a schoolroom need 2,000 cubic feet of fresh air per pupil each hour. Students of high school age need 2,500 cubic feet. This does not mean that they will individually breathe so much, but that each will vitiate that amount. They will each breathe approximately 18 cubic feet per hour, but when a breath of air is exhaled it has lost so much of its oxygen and has taken up from the blood so much carbonic acid gas that one exhaled breath will vitiate more than a hundred times as much fresh air to such a degree that none of it will be fit to breathe. This vitiation consists in reducing the normal amount of oxygen, but especially in increasing the normal amount of carbon dioxide and throwing into the air bad odors and possibly some sort of toxic agent produced through fatigue. The last element is still somewhat in doubt, since the experiments of Billings, Mitchell, and Bergey, and yet a recent German authority announces the discovery of a poison comparable to that announced many years ago by Brown-Séquard and D'Arsonval. Whether this is final or not we can not say, but we do know that we can not hope to furnish normal, healthful schoolroom conditions without furnishing at least for each child more than a hundred times as much fresh air as he breathes. Hence any method of ventilation devised for schools must meet this demand, and meet it regularly, and at all times during the day and at all seasons.

It is possible, as we have suggested, to do this in very cold weather by a well planned and ample gravity system, but in warm or mild weather it is utterly impossible without overheating the room. I wish these facts could be made plain to all school boards, especially in those parts of our country where during the school year there are very few days of very cold weather. Such knowledge would save hundreds of thousands of dollars annually, and, better still, aid in safeguarding the health of a much greater number of school children.

A furnace of ample size will *warm* and *ventilate* a home in mild or cold weather, but it will not ventilate a school under like conditions, simply because a schoolroom must be supplied with a great deal more fresh air than a home. Shrewd but dishonest agents make the ordinary school board in our towns and villages believe that the impossible can be accomplished. Teachers even are not wholly free from this deception. I know of no way to put a stop to this waste of money and this willingness to take the word of dishonest dealers save through general education of the masses, so that members of school boards would either be able to know what to do or else know enough to call to their aid disinterested expert service.

In the section on "Heating of School Buildings" the reader will find a discussion on indirect systems of heating by means of hot-air furnaces and steam coils, and it is unnecessary to speak of this subject here. Our problem is now that of ventilation. Suppose the question is asked, Why not ventilate by opening windows? The first answer will be, we *must* do so in warm or mild weather unless some better way is supplied. If we depend on gravity to lift warm air from heating surfaces in the basement to the schoolrooms to supply the requisite heat, then, save in very cold weather, the rest of the fresh air needed must come in by way of open windows or doors. But under these conditions it is next to impossible to prevent drafts, to keep an even temperature throughout the room, and to distribute the fresh air in such a way that there will be no stagnant foul air in the corners or at the breathing line. It is not enough to introduce the requisite amount of fresh air; it must be so thoroughly circulated in the room that all the children will have easy access to it and when vitiated discharged to give place to a fresh supply which should be continually entering. But suppose another condition: If it is as warm outside as it ought to be in the schoolroom, what will cause a circulation of the air even though the windows are all lowered? Nothing but the wind, overheating the air in the schoolroom, or some mechanical force to drive in fresh air and crowd out the foul. If, as we have assumed, the weather is warm, of course no fire can be built to cause an upward flow of hot air, for it is already hot enough in the schoolroom. Wind can not be depended on for the windows may open to the leaward. Even if they were



facing the wind, there would not be enough force to clear the room unless it is strong enough to produce drafts. Some people act as if they really thought the air were alive, and would just jump into an open window regardless of temperature conditions. Truly there is still a great amount of animism left over from the days when the race was in its childhood. Many adults still think as a child thinks when it is riding a stick horse or talking to a rag doll.

There is only one way open to us, then, in the construction of a school building if we wish to insure effective ventilation in all kinds of weather and in the varied climates of our country. Provision must be made to install a fan and the system of ducts necessary and some form of motive force to drive the fan. There are two methods of using a fan that deserve consideration. A fan may be set in the attic or upper part of a building and arranged to draw the air through the rooms by creating a partial vacuum in the ducts leading from the fan to the rooms below. This is the vacuum or exhaust system. Or the fan may be set in the basement to drive the air into the rooms and by reason of the pressure exerted there to force the vitiated air out through ducts leading from the rooms to a central duct or ducts connected with the outer air above the building. This is known as the "plenum system." Still again in large buildings these two systems may be combined, so that by the use of two fans, one below and one above, the combined effect of push and pull may be secured and a more rapid circulation maintained. If the exhaust or vacuum system is used alone, it is clear that the pressure of the air in the schoolroom will be less than that outside in the open air, and hence there will be a pressure exerted toward the schoolroom from all directions. Every crack in the floors, walls, and ceilings, as well as those about the doors and windows will permit the entrance of air, and unless the room is almost air-tight, save at the openings of the ducts for the entrance of the air from the furnace or fresh-air chamber below, it will be impossible to prevent disturbing and dangerous drafts in cold weather. Furthermore, it will be almost impossible to regulate satisfactorily the source from which the air is taken to supply the schoolrooms. Under the condition of a partial vacuum thus produced air from all sources would enter the room, and this would of necessity introduce difficulties other than that of drafts. Air from halls more or less impure, from cloakrooms, and, on the lower floors, from basements would almost inevitably find entrance to the rooms, bringing impure ground air and the odors associated with such sources. In addition there would be more dust brought in through floors and walls than would otherwise enter the rooms. The difficulties associated with a fan located in the attic or upper part of a building (it would work at a great disadvantage in any other location) should also be taken into consideration.

A fan so located is likely to cause disturbing noises and vibrations despite all precautions which can be taken, and these would be heard and felt throughout the building. Besides, when a fan is so far removed from that part of the building where the janitor must spend most of his time during school hours, there are dangers due to fires induced by hot boxes or by faulty electric connections, for it is plain that the janitor could not give as much attention to either the management of the basement or the fan when his work is thus divided. A fan in the attic would have to be run by an electric motor, while below, if found more advisable, it could be run by a steam engine. Taking all things into consideration, it is never advisable for schoolrooms to depend on the vacuum system.

When a fan is set to drive the air into the schoolrooms, it of course must be set in the basement to get the best effects. This offers opportunity to set it firmly on a bedding wholly disconnected from the structural parts of the building, and in this way to prevent entirely any vibrations. It will then be easy of access, and the engine or electric motor arranged to drive it, can be securely set and operated with the least danger and expense, and much more safely supervised. But the chief value of this placing will arise by reason of the fact that the source of the air to be delivered to the schoolrooms can be controlled and the dust and dirt can be filtered out of it, and more moisture added to it when needed, if the precaution is taken to install a filtering and humidifying apparatus.

The vacuum system further introduces many disturbances in ventilation which arise during cold and windy days. When schoolrooms are exposed directly to a cold, strong wind, the vacuum system will magnify the difficulties, for it will offer no hindrance in the way of pressure to prevent drafts, but will actually make it easier for the wind pressure about the windows and porous walls to drive the air in. On the leeward side of the building it would, by the aid of the partial vacuum produced by the suction of the wind, cause such a vacuum that it would be difficult to prevent this side of the building from making undue demands on the heated air in the basement, and thus introduce one of the most fruitful causes of complaint in cold weather, viz, unequal distribution of heat and ventilation in the various rooms. The only way to use a vacuum system to prevent these difficulties would be to have two fans in the attic connected up with opposite sides of the building, and manage them so as to minimize the effect of the wind; that is, limit their speed as conditions demanded. But this arrangement is not practicable, both on account of the expense and the complications introduced in management. Where a plenum system is used it can be seen at once that the pressure within the room thus produced will operate to minimize the amount of air which would be driven into the schoolroom on the windward side

by the force of the wind and thus not only save fuel, but prevent drafts. On the leeward side the difficulties due to the suction of the air would not be entirely relieved, but on the whole they would probably not be so great. Still we must not overlook the fact that the rooms on this side would, unless the entrance ducts were adjusted to prevent, cause more demand on the fan than the opposite side on account of the lower pressure of the air in the rooms. The only effective way to avoid the difficulties in heating and ventilation due to strong, cold winds is to construct the walls of schoolrooms in such a way as to prevent the winds from driving through on one side and exhausting from the other. Double windows made to fit as closely as possible without binding, and walls protected by deadening felt, are in cold climates economical in the long run and altogether desirable. Strong cold winds are the causes of much more serious disturbances in heating and ventilation than ordinary observation would indicate.

Tests made by Mr. W. H. Whitten and others show that these disturbances are often so great that what would otherwise be an effective heating and ventilating system is, during the continuance of what would even be regarded as a moderate wind, altogether unsatisfactory. Without going into details presented by him, it will suffice here to say that the figures presented make it imperative for architects to take definite account of the influence of the wind if they would expect to insure an even distribution of heat and satisfactory ventilation in cold, wind-swept locations. (See digest in *School Board Journal*, October, 1909, and, for a shorter report, the *Engineering Record*, v. 60, No. 10, p. 264.)

It will not be necessary or even advisable to enter upon a discussion of the cost of fans or the most effective kinds now on the market. This part of the work of a school board should be performed by some competent and disinterested engineer. Not one school board or teacher in a thousand will be competent to pass upon the effectiveness of any system of mechanical ventilation on the market. Furthermore, if school boards depend on the advice of engineers interested directly or indirectly in the sale of any system, they are in danger of being deceived, either knowingly or through unconscious prejudice. Having determined on the size of a building and a given arrangement of rooms, halls, and basement, it is the duty of all school boards to call to their aid the expert disinterested service of a competent engineer to devise plans for heating and ventilation. To this advice it may be said that "we are depending on our architect to perform this service." In reply, it will in no sense detract from the dignity of the work of a modern architect to say that very few architects have sufficient technical knowledge and information to know what is the best and how to calculate for efficiency and economy in details

of this sort. Most of them depend on representations made by manufacturing concerns, and in this way expose themselves either to deception on the part of such firms or to criticism for their selection of appliances. Contracts for building a schoolhouse can be segregated, stipulated results demanded, and thoroughly tested before payments are made. Any honest firm supplying fans, ducts, and motors for a system of ventilation will be willing to accede to such demands, for it offers to them the best advertisement and commendation they can get in any way.

I have intimate knowledge of a situation where an architect, one of the most renowned in his profession, permitted, either through ignorance of the principles of ventilation, or through dependence upon the representations of those more eager to supply the appliances than to make certain of results, or through limitations in expenditure by the board of education, the installation of a system totally inadequate to meet the demands. The seriousness of such a mistake will be better understood when it is said the fireproof construction of the building offers no opportunity for correction without entailing enormous expense. By all means in this day of specialization get honest and competent specialists to do your work after duly entering into a plain and definite contract for what you need. Let me illustrate what I mean, and at the same time emphasize some of the essentials of a good system of ventilation.

It was pointed out earlier in this chapter that each pupil of high-school grade must be supplied with at least 2,500 cubic feet of fresh air per hour while in the class room, else he will not be able to do his work under healthful conditions. Suppose there are 40 such pupils gathered in a class room, then 100,000 cubic feet of fresh air must be delivered to that class room each hour and properly distributed and circulated throughout the room. The amount is a moderate estimate, and in no way the figures of one who is over enthusiastic. Morrison states upon the basis of calculations that "small children require 2,000 cubic feet; high-school pupils 3,000, and college students 3,500 cubic feet per hour." (*Ventilation of School Buildings*, Gilbert B. Morrison, p. 39.) Carpenter urges 3,000 cubic feet per hour per pupil. (*Heating and Ventilating Buildings*, Rollo C. Carpenter, p. 432.) Allen says, "Schools need 2,400 cubic feet per hour for each pupil." Woodbridge says, "Schools should have 2,500 cubic feet per hour per pupil." Parker says the following amount of fresh air should be supplied to healthy people when in repose (per head per hour):

	Cubic feet.
Adult males .....	3, 500
Adult females .....	3, 000
Children .....	2, 000
Mixed audiences.....	3, 000

It has been determined with approximate certainty that air which has been vitiated so as to contain more than 6 parts of carbon dioxide in 10,000 is unfit to breathe and harmful, especially when other unwholesome elements are present. Now, the plain and sensible thing to do is to calculate how many pupils the building to be constructed will accommodate when taxed to its maximum capacity and then put the problem to manufacturers of fans and ventilating machinery, thus: "We want a fan, a motor (electric or steam engine), and the necessary ducts installed to furnish 2,500 cubic feet of fresh air per hour for each pupil (stating the number). Can you furnish it? Will you insure its capacity when running at a normal speed in mild weather and submit to the results of tests made by a competent engineer, whom we shall select? If so, what will it cost? The plans and specifications of the building can be had on application." I do not mean to suggest that this or any other specific form of dealing with these problems should be used. But I do want to insist that some plan embodying these suggestions would save us from great vexations and almost numberless errors. For example, if a fan and its driving machinery is furnished by one dealer and the ducts by another, unless definite figures are furnished what would otherwise be a success ends in failure. I venture a guess that more plenum systems of ventilation have proved ineffective in our schoolhouses by reason of the use of small, badly proportioned and badly placed air ducts than by reason of the capacity of the fans furnished. It is a most common blunder to undertake to deliver a given amount of air through long horizontal ducts without making sufficient allowance for the great friction offered to the passage of the air through them or for its loss of heat before it reaches the schoolroom. No one can hope for success in the use of a plenum system who permits these ducts to be constructed by guess or placed at random. It requires complicated calculations for each specific situation to properly arrange and correctly proportion these ducts. But suppose a large fan is furnished, proper heating surfaces are installed, ducts for the air are exactly proportioned, what else is there to do? To answer this question let us first in imagination go into the classroom. The fresh-air duct for a given room should open from an inside wall about 8 feet from the floor. The opening, if but one is needed, should be nearly opposite the center or middle of the room and in the long side of the room. The mouth of this duct should be larger in both dimensions than the duct itself and made flaring on the upper and both lateral sides. These modifications will operate to reduce the rate of the incoming air and insure a better distribution of it over the room. In some cases it is advisable to put some thin tilted gratings from side to side across this opening in order to direct the air toward

the ceiling, to give it better distribution, and prevent the possibility of short circuiting.

The exit ducts, at least two in number, should open into the wall near the floor on the same side of the room through which the fresh air enters, if there is no cloakroom directly connected with the classroom. The position of these exits will depend to some extent on what might be termed the center of population of the classroom. Generally speaking, if one is 10 feet to the right and the other 10 feet to the left of a vertical line drawn from the entrance duct, they are well placed. The usual custom is to shield the opening of an exit duct by a wire grating fastened securely and flush with the wall. I do not regard this advisable, and prefer these openings to be finished somewhat like a fireplace opening, and left without gratings of any kind. My reason for this is the fact that where gratings are used these openings are always dirty. The lint and dust, and occasional scraps of food surreptitiously deposited, are hard to remove. As a result, they are usually untidy and unhygienic. When finished and left open as suggested, they can be kept clean. In addition, gratings hinder the exit of the foul air more than is generally estimated.

In case cloakrooms open into the classrooms, as recommended for grammar schools, one exit duct should be placed in the cloakroom and large coarse gratings in the lower part of the doors to permit the air to be driven through the cloakrooms to keep the air pure and to warm and dry the wraps if damp. With cloakrooms so arranged, I have found that good results can be obtained by opening the exit duct in the cloakroom 6 or 8 feet above the floor in the inner end of the room or in the center of the inner wall. It may seem unnecessary to some to mention the fact that these ducts must always be on the same side of the room as the entrance duct, in order to insure a complete circulation of the air in the room. But it is not unusual to find them located elsewhere. Architects who do not understand the difficulties of schoolroom ventilation may locate them where convenience suggests, and thereby introduce permanent troubles. The size of the exit ducts should be calculated by an expert engineer, and their connections with the outer air made so as to offer as little friction as possible. It is good economy to cover all air ducts with asbestos to prevent the loss of heat. This applies to the exit ducts as well as to those designed to deliver the fresh air.

Hallways need warming and ventilation, but it is not possible to make any suggestions here that would be of a general value, because halls are not standardized as to shape and size as classrooms. Perhaps it may be of some service to say that in cold climates some provision should be made for foot warmers, and these are generally more convenient when placed in halls.

Thus far nothing has been said of the main entrance for the fresh air to the fan and heating surfaces. This is an important unit in the system. In the first place, the air should be drawn from the purest source available, and if possible from the south side of buildings, especially in the colder sections of our country. The air on the south side is from 5° to 10° warmer than on the north side, and hence a corresponding saving will be made in fuel. The outer opening to the fresh-air room should be at least 6 or 8 feet from the ground, in order to keep clear of ground air and to prevent as much as possible the entrance of dust. The fresh-air room and the passage leading to it must be clean and as nearly air-tight as it can be made to prevent any contamination through dust or foul air from basements or other objectionable sources. To this end the air should be taken from a source not polluted by dust from streets or roadways. Unless these things are clearly and definitely settled before a building is located it is often difficult to arrange accordingly. Too often these essential conditions are not well considered, and after the building is under construction it is too late to change, and then the proper location of ducts, fans, and other essentials is impossible.

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## SCHOOL ARCHITECTURE AND SCHOOL IMPROVEMENT.

This is the age of schools and schoolhouses, as characteristically as the later part of the middle ages was the period of churches and great church buildings. In each case, the faith and fervor of the people can be read and fairly understood through a critical study of these objective results and the ideals for which they stand. It will not miss the mark very far to say that our ideals and feelings associated with the notion of popular education are becoming suffused with a glow and zeal heretofore only found associated directly or indirectly with religious faith and religious propaganda. And something of the same spirit that once wrought to build a tabernacle or a cathedral worthy of a dwelling place of the Most High, is seeking expression in furnishing to the youth of our land nobler temples in which their hearts, minds, and bodies may better adjust themselves to the demands of a practical civic brotherhood. Whoever, then, undertakes to build a schoolhouse to meet and foster these ideals ought to approach his task with holy hands and a consciousness of the devotion which it is to typify.

The problem, then, of building a schoolhouse to-day is in no small sense complicated by the growing tendency to use schoolhouses for all sorts of attempts at social betterment. Schoolhouses, especially in the large cities, have come to be used night and day, summer and winter. Vacation schools have been established, in which unusual

programs of work and play have been introduced, and for their successful consummation such programs often demand equipment and accommodations not needed in the regular day schools. Lecture courses have been introduced not primarily for school children but for those who have quit school and gone to work, for those adults who have a desire to keep up their intellectual interests, and for those also who have sufficient spiritual pride to begin even late in life. But such buildings demand special equipment in the way of lighting, stereopticons, photographic rooms, assembly halls readily accessible, chairs, platforms, etc.

Manual and technical training courses have been introduced, demanding power plants not heretofore needed, or at least not thought desirable. Playgrounds are in greater demand, not only for the regular school children, but for those who for various reasons are denied school privileges through the day. Such children may come in the evening, after school hours, or on holidays. This demand for greater space and better adjustment led to roof playgrounds on school buildings. But no sooner had they been built than it was discovered that such favored and well-ventilated areas could be utilized as social gathering places; where good music could be heard; where the young people could meet and enjoy social dances under wholesome and safe environments; and where society could institute rational competition with the cheap vulgar shows and dangerous dance halls rampant on the streets below.

The work suggested by these efforts has been limited mainly to the large cities, especially to New York City, Boston, Philadelphia, Washington, and Chicago.

But there are social movements in almost every community in our country looking toward educational betterment, and such movements should be fostered, guided, and rationalized. Whenever these are for any worthy reason disconnected from church organizations, either the public-library building, some building designed especially for social workers, or the public-school buildings ought to be available as a center for such workers.

The school building has many advantages, for it is the citadel of a democracy, and there has developed about it a sentiment of dignity and decorum, influential in all movements undertaken within its precincts. Furthermore, the use of these buildings for worthy social work of all kinds is bringing school work into more vital touch with the real life of the world; vice versa, it is bringing the American community into a more vital relation with the teachers and those who are responsible for schools and school organization.

In planning even a country schoolhouse or village high-school building, one must therefore think out into the possible needs of the



community and enlarge his usual notions of the scope and purpose of public-school education.

And just here I desire to express the wish that some day in the near future more pains will be taken to make schoolhouses beautiful in external appearance as well as commodious and healthful within. Thus far the architects of the large majority of our smaller school buildings have clung tenaciously to the "schoolhouse type," and have given us, in the main, buildings devoid of any attempt at niceties of proportion or unity of design. In many cases attempts at cheap ornamentation have been made at the expense of real beauty of form and hygienic considerations.

It seems strange, on first thought, that our schoolhouses have been the last of public buildings through which public taste has sought to express itself. But when one recalls that this tardy recognition of children's rights has exhibited itself in all lines of endeavor wherein the education and care of children were concerned, a fundamental phase of human nature is brought into light. Adults have regularly thought and planned first for the satisfaction of their own needs rather than those of the children. If the reader is inclined to doubt this, let him make a study of the Sunday school rooms of our churches and compare them with the rooms of the same buildings set apart in the main for the use of adults. Let him examine the homes and contrast the provisions made for adults with those for the children, and he will understand more clearly what I mean. Even children's clothing is designed not so much for personal comfort, joy, and approval of children as for the satisfaction of older people. Precisely for the same reason that the education of children at public expense has been in the main the last phase in the development of our educational systems, we may expect that schoolhouses for the little children will not receive as careful attention from the general public in our generation as those designed for college students or students of our secondary schools.

I wish here to enter a protest against this selfishness, and at the same time to make a plea for the sake of the æsthetic education of the children and through them the development of an enlightened conscience and æsthetic sense in the public at large. I know of no class of public buildings deserving of more sincere thoughtfulness and artistic treatment than those school buildings designed to accommodate our children who here spend a great part of their waking hours during their early years. I know of no better opportunity for art leagues to express themselves for civic improvement than by setting themselves the difficult task of offering, to those who have charge of the construction of our country schoolhouses, artistic and well-adapted plans for their consideration. Such plans must be simple, easily followed, and they must call for materials within the reach of local

markets or conditions. Country schoolhouses are, in the main, built by "hatchet-and-saw" carpenters who can not read complicated drawings or follow readily the usual forms of specifications. Proportion in such buildings is almost everything, and to secure this end plans ought to be drawn and specifications devised so explicitly that no mistake can be made. No amount of interior decoration will offset the bad effect of exterior ugliness.

If country people are inclined to be careless about the appearance of their schoolhouses and school grounds, and we all know that this is often the case, it becomes a double duty for those who have better taste to exert themselves to place before them better models. Real beauty is not expensive. The best things are in reach of us all. Log cabins can be built as satisfying to the artistic sense as palaces, indeed frequently more so. The planning of a one-story, one-room country schoolhouse ought to demand, and will demand from any capable and conscientious architect, as painstaking consideration as a large city school. In fact, it seems to me that the opportunity for the development and dissemination of taste in this, the central agency for social and æsthetic improvement in the country, ought to appeal with especial interest to all concerned.

Here is an account of the influence of one teacher "who organized a community" (*World's Work*, vol. 5, p. 9601):

In September, 1904, Miss Mabel Carney, a young Irish girl just out of normal school, began teaching in a country school in Putnam County, Ill. Her pupils were few, the building dilapidated and poorly equipped, the site unattractive, but she was a teacher of practical ideas. Two neighboring schools were in a condition equally bad, and Miss Carney went to work on a plan of consolidation. She talked consolidation of these three inefficient country schools until she had won hearers enough to put the question to a vote in the spring of 1905. The electors voted down the proposition that year, but the young teacher's consolidation plan was adopted at the election in 1906. Here are some of the concrete results: Mr. John Swaney, a public-spirited citizen, gave 24 acres for a campus—a campus for a country school! The people of the three districts voted \$18,000 to make the building one of the best schoolhouses in Illinois. Wagons carry the children who are too remote from the building to walk. The principal of this country school is paid \$1,000 a year. On the campus is an agricultural experiment plot of 6 acres, conducted in cooperation with the school of agriculture of the State University, and a large tract of natural forest. A four-year high-school course is offered, with a liberal election of studies. Country boys and girls may here study agriculture, animal husbandry, horticulture, domestic science, and all phases of work vitally related to the fundamental means of a people living in the country. Culture subjects are not neglected, but the real basic interests of culture among an agricultural people are given due emphasis. An enlarged country neighborhood has been bound into a co-operative social unity, whose possibilities for higher culture are not inferior to those of cities of 10,000 people. These are the products of two years' work of a young girl with the right ideals.

Whether this account is true in all particulars or not, the opportunities for services suggested by such work are offered on all sides. *Things can be done* even where conditions seem most unfavorable, if those who know are willing and set themselves to the task.

It may be of general interest to note in this connection that from the point of view of the work of school-improvement societies the South is certainly surpassing the North or West. The teachers and public-spirited women of the South have organized this work and made it effective. Perhaps the spirit of the workers, as well as one method of attack, can be best shown by the announcement made for 1909 by Miss Theodosia Dargan, president of South Carolina School Improvement Association:

The South Carolina School Improvement Association offers 35 prizes to the schools of the State for the most decided material improvement made during a given length of time. Five of the prizes are to be \$100 each and 30 are to be \$50 each. Regulations concerning the 35 prizes that are to be awarded by this association are as follows:

1. Improvements must be made between November 1, 1908, and December 10, 1909.

2. Prizes will be awarded to schools where the most decided material improvements have been made during the time mentioned.

3. Under material improvements are included local taxation, consolidation, new buildings, repairing and painting old ones, libraries, reading rooms or tables, interior decorations, beautifying yards, and better general equipment.

4. No school can compete for any of these prizes unless it is a rural school. No town with more than 400 population shall be eligible to the contest.

5. All who wish to enter this contest must send to the president prior to October 1 the names and descriptions of schools before improvements are made.

6. All descriptions, photographs, and other evidences showing improvements must be sent to the president before December 15, 1909. The chairman of the board of trustees of any school that is competing for a prize must approve all descriptions before and after improvements are made.

7. Blanks will be sent to schools competing for the above prizes, with questions to be answered relating to the conditions under which the improvements have been made.

8. Prizes will be awarded in checks at the annual meeting of the School Improvement Association, December 31, 1909. The prizes are to be used for further improvements in the schools receiving them.

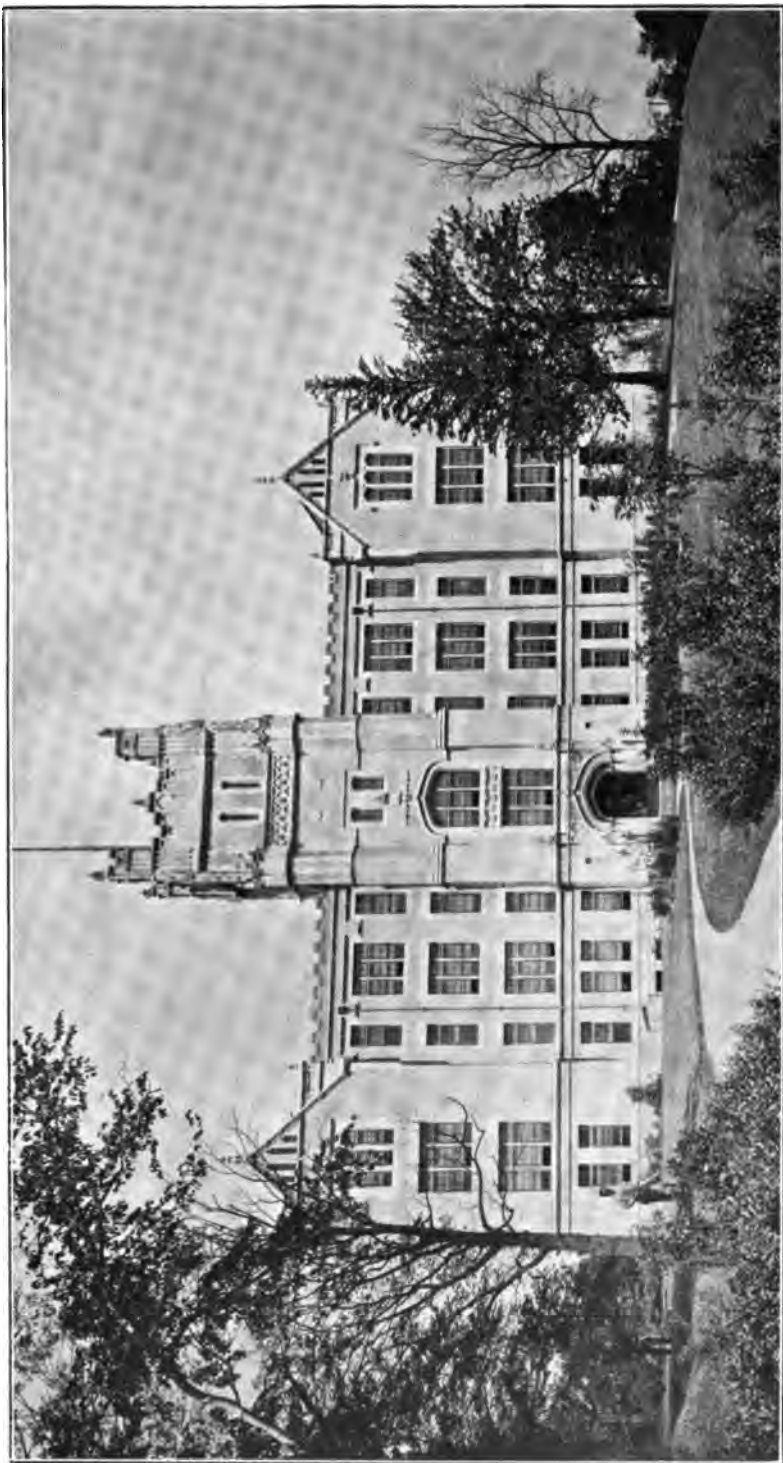
Address all communications to Miss Theodosia Dargan, president South Carolina School Improvement Association, Dalzell, Sumter County, S. C. (*Bulletin IV, School Improvement Association of South Carolina*, issued by the State superintendent, p. 12.)

It has been the custom in many places in our country to build school-houses according to ready-made plans furnished by so-called architects and builders. These plans are rarely sufficiently accurate and complete to give any definite idea of what will result as the finished product. Their specifications are indefinite and not infrequently in error, and trouble and extra expense result from attempting to follow them. The sane and economical thing to do, even if only a one-story

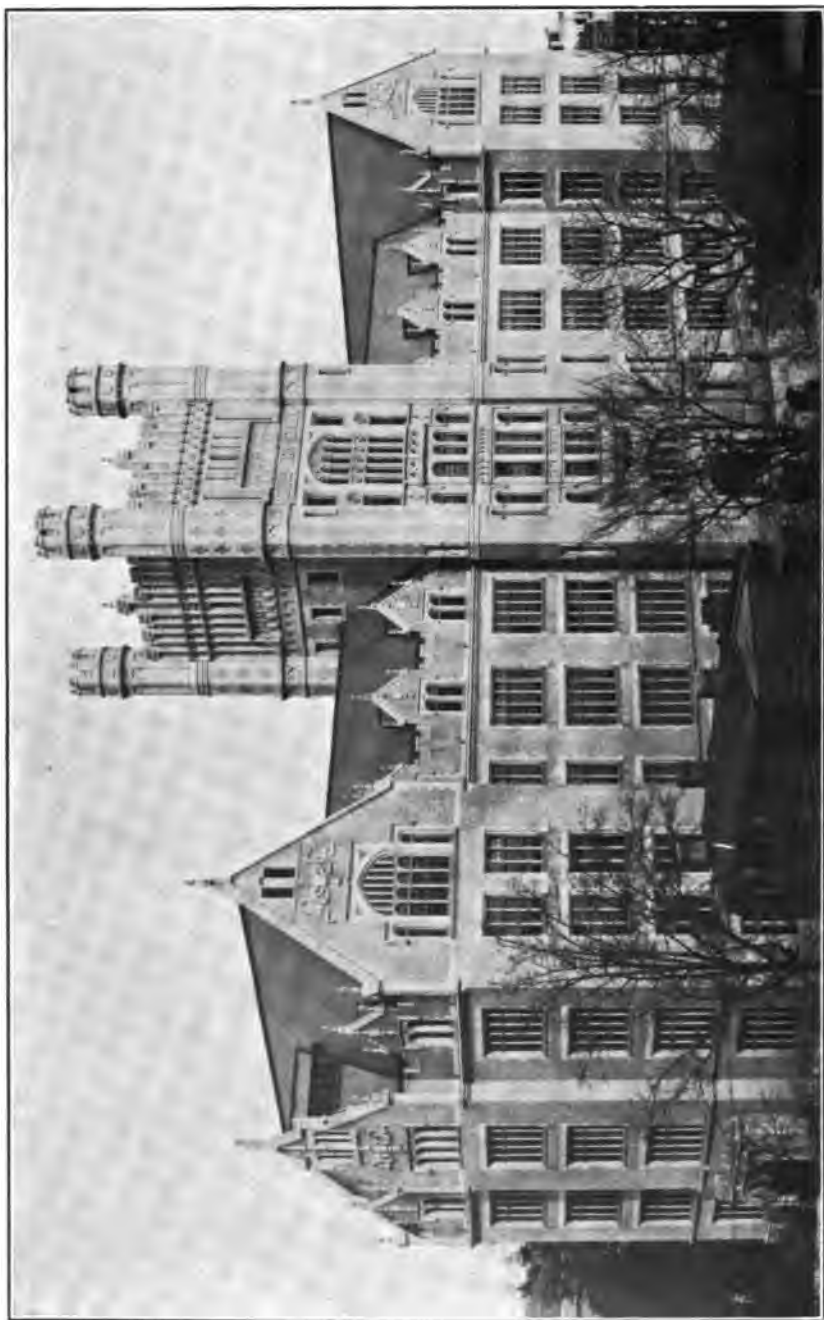
school building is to be erected, is to engage the services of an honest, tasteful architect, and with him work out every detail before the plan is finally accepted. And upon school boards of towns and cities I wish to urge with all the emphasis I can, that they give their teachers, or at least a committee from the teaching force, a large share in helping to plan their schoolhouses. It seems more than strange that members of a board of education who rarely have any intimate acquaintance with the demands and necessities of modern school buildings should, when called upon to erect new buildings, neglect to avail themselves of the services of the experts they have selected to do the school work. Again and again I have seen boards of education come together to consider plans which had been placed in competition without so much as inviting a principal or superintendent to aid them. One by one the architects are called before them to extol their products and point out the superiority of their respective plans to all other possible plans; and I have noticed that in general the most plausible talker, with the gaudiest elevation, and the greatest number of impossible carriages passing the proposed building, generally gets the vote. If the floor plans are studied at all, they receive a mere glance, and generally from eyes unable to read them intelligently. The fact is the planning and building of schoolhouses is a highly specialized business and can not be safely left in the hands of men who know nothing about it. In every system of city schools, whether a regularly employed architect is available or not, the superintendent of schools ought to insist that a committee from the teaching staff should with him be empowered by the board to study plans and advise architects on all matters pertaining to arrangements most suitable for practical school work. This committee ought to be a standing committee, and should be in every way encouraged to study in detail schoolhouses from the educational point of view. It is certainly very poor economy to neglect to utilize the teachers' intimate knowledge of what is needed. The same sort of a policy ought to be encouraged in villages and in country districts. County superintendents ought to be given power to pass on all plans for school buildings; or, better still, they ought to have at command data from which architects can work, and then through advice and direction guide to better plans.

In a large city system of schools where an architect is employed to make plans for all the schoolhouses to be built, and gives his whole time to this specialty, there is less waste and better results. And yet even these specialists can often profit from the suggestions teachers are able to give. But in the great majority of places there is no architect regularly employed, and few who know much about the special problems of school buildings. Under such conditions a cus-

tom has sprung up of advertising for competitive plans, and then is enacted the farce described above. Indeed several States have made it compulsory for school boards to select plans in this way. There can be no question that this in general is a clumsy and ineffective method. The safe and businesslike thing to do is to engage an architect and let him work up a plan under guidance, so that when it is done it will be understood. The best architects rarely submit plans in competition. It is too expensive for them to prepare worthy plans on a mere chance. But school boards have a difficult political problem to meet when they select an architect, and the competition system has furnished them a means of forestalling criticism, and often of compelling the acceptance of unsuitable plans. Not one business block in a thousand is built after plans secured through competition, and the very men who serve on school boards would never manage their own business in this way.



CURTIS HIGH SCHOOL, BOROUGH OF RICHMOND, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT. THIS LOCATION IS SUGGESTIVE OF PURE AIR AND UNDISTURBED WORK.



MORRIS HIGH SCHOOL, BOROUGH OF BRONX, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT. A BEAUTIFUL BUILDING.



F. LOUIS SOLDAN HIGH SCHOOL, ST. LOUIS, MO. WM. B. ITTNER, ARCHITECT. ONE OF THE FINEST HIGH SCHOOL BUILDINGS IN THE UNITED STATES, AND WORTHILY NAMED. (FOR DETAILED DESCRIPTION, SEE APPENDIX B, PAGE 111.)

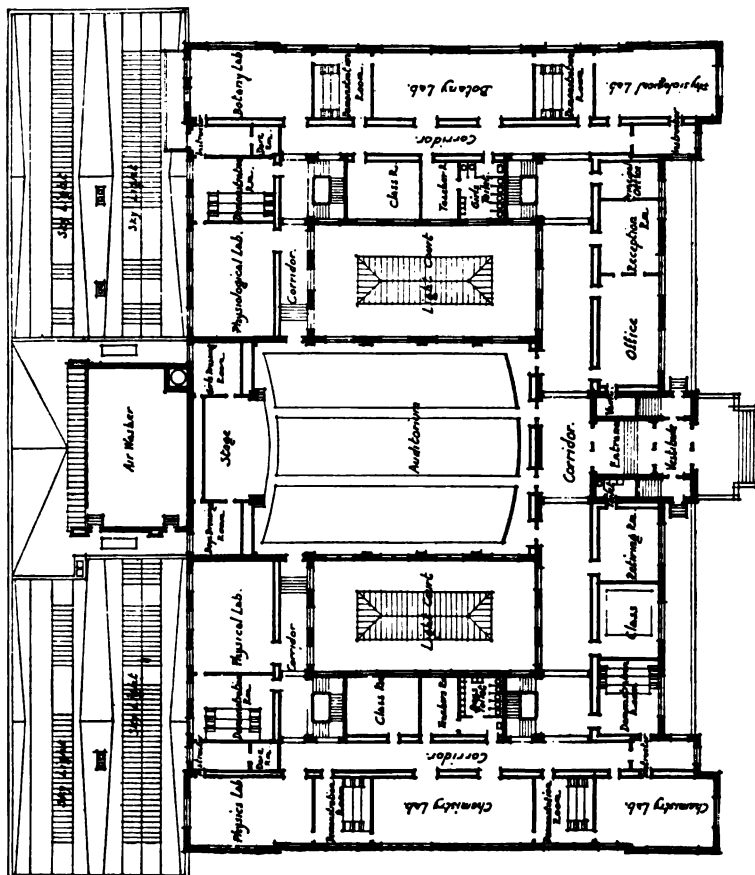




F. LOUIS SOLDAN HIGH SCHOOL, ST. LOUIS. DETAIL OF THE MAIN ENTRANCE.

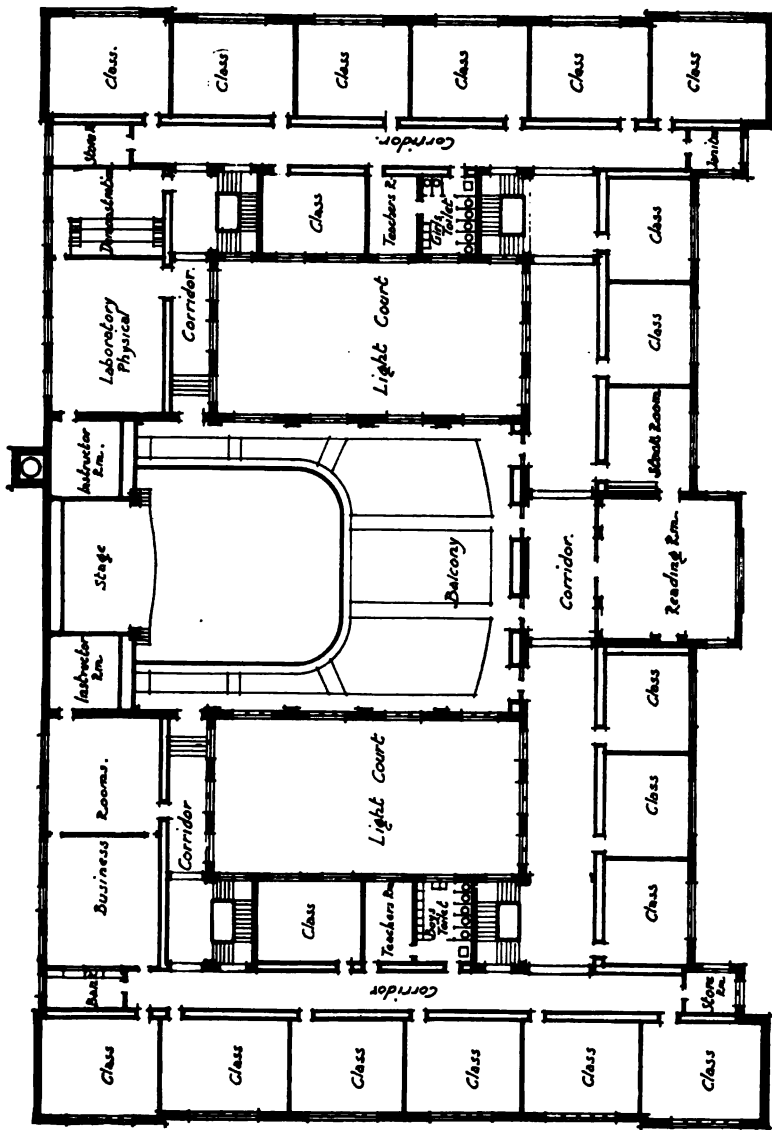


UNION BOULEVARD.  
F. LOUIS SOLDAN HIGH SCHOOL, ST. LOUIS. BASEMENT PLAN.



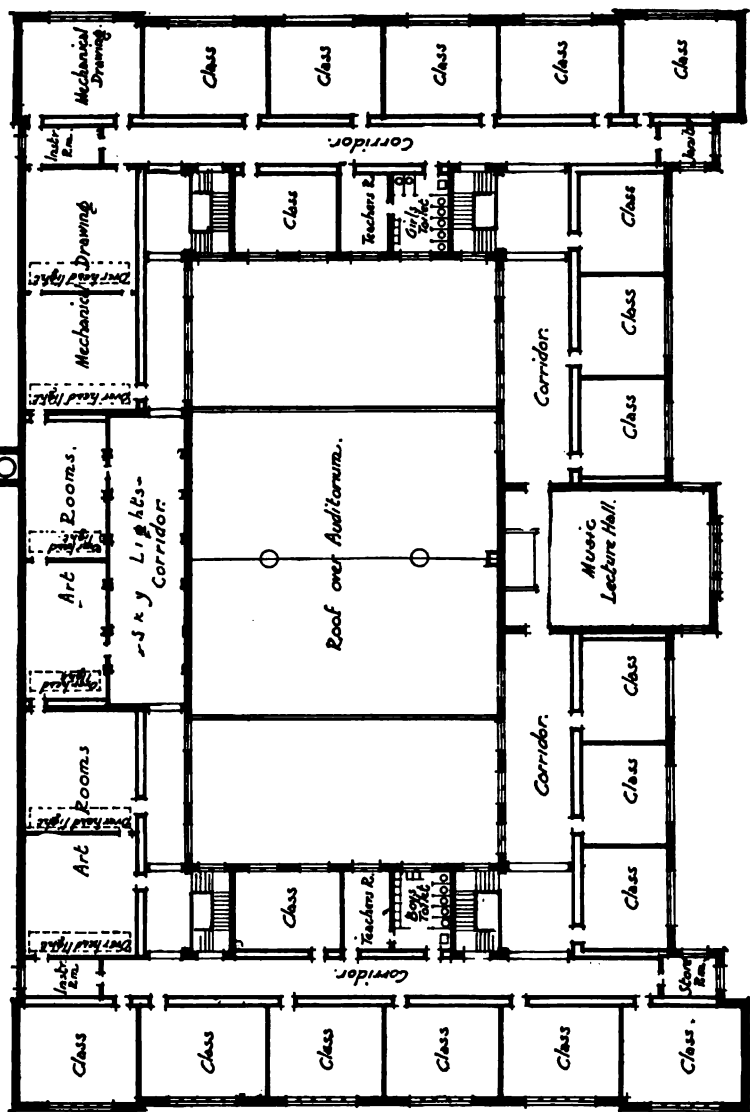
First Floor Plan

F. LOUIS SOLDAN HIGH SCHOOL, ST. LOUIS. FIRST-FLOOR PLAN.



*Second Floor Plan.*

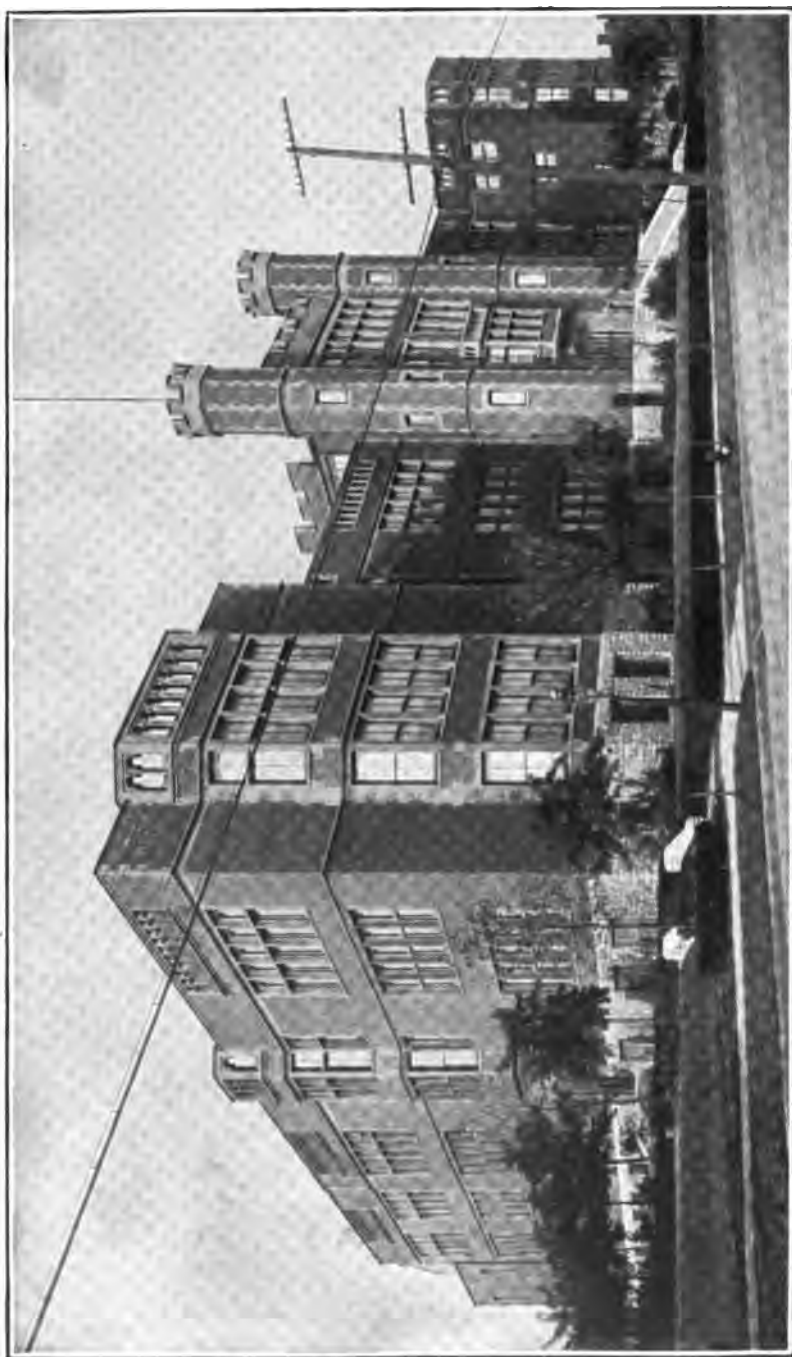
F. LOUIS SOLDAN HIGH SCHOOL, ST. LOUIS, SECOND-FLOOR PLAN.



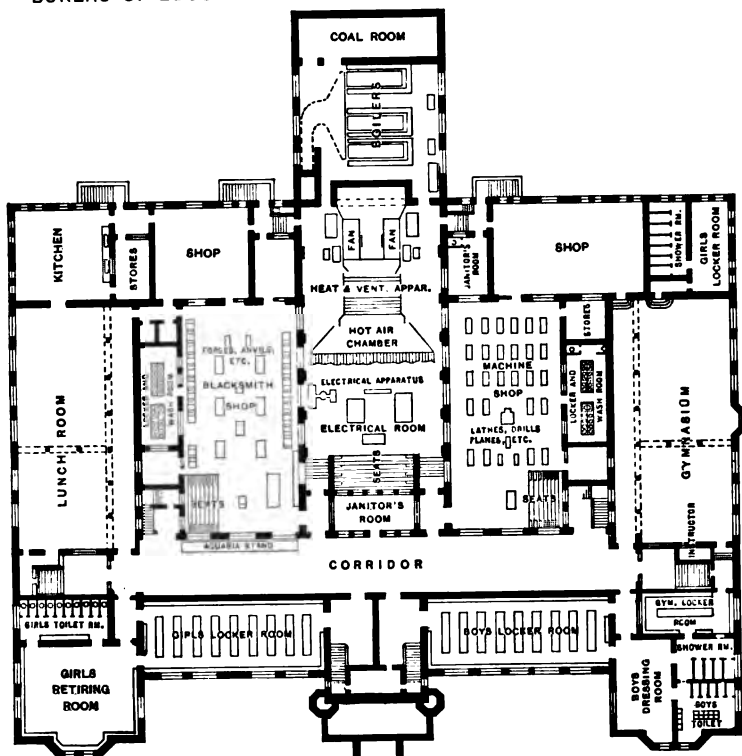
F. LOUIS SOLDAN HIGH SCHOOL, ST. LOUIS. THIRD-FLOOR PLAN.



SUMNER HIGH SCHOOL, ST. LOUIS, MO. WM. B. ITTNER, ARCHITECT. (FOR DESCRIPTION, SEE APPENDIX B, PAGE 115.)

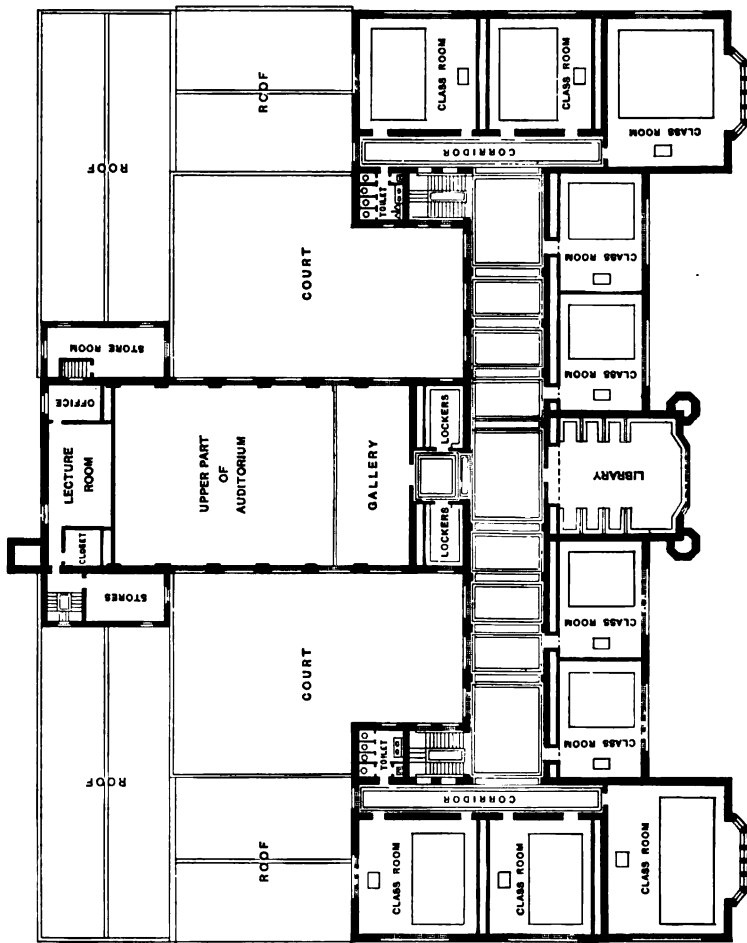


McKINLEY HIGH SCHOOL, ST. LOUIS, MO. WM. B. ITTNER, ARCHITECT.

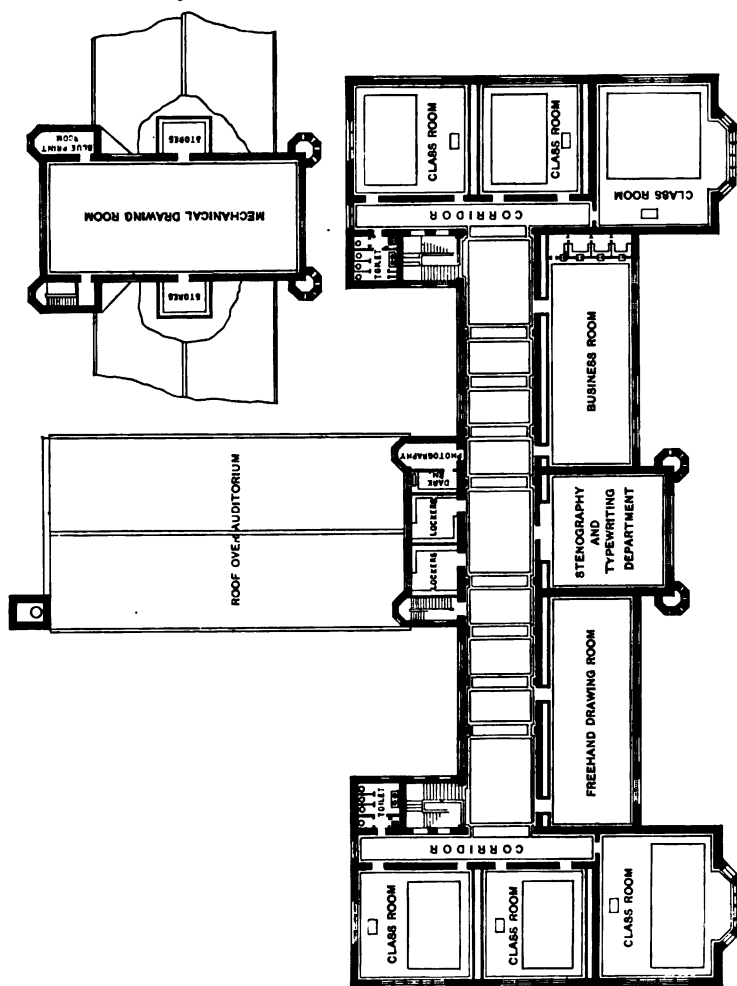


MCKINLEY HIGH SCHOOL, ST. LOUIS. BASEMENT PLAN.





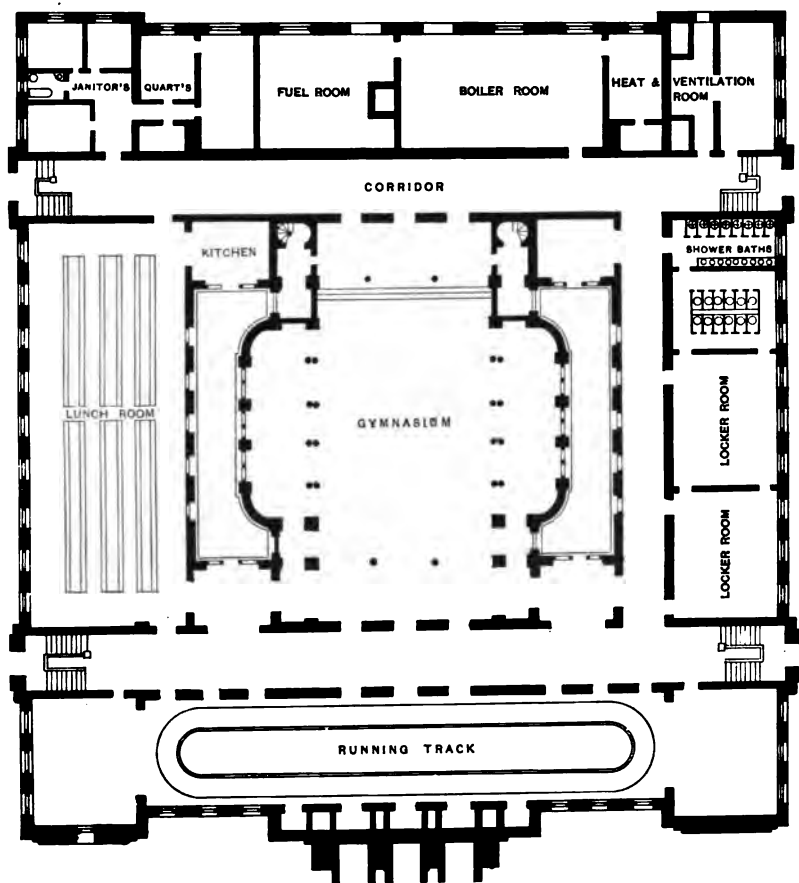
McKINLEY HIGH SCHOOL, ST. LOUIS. FIRST-FLOOR PLAN.



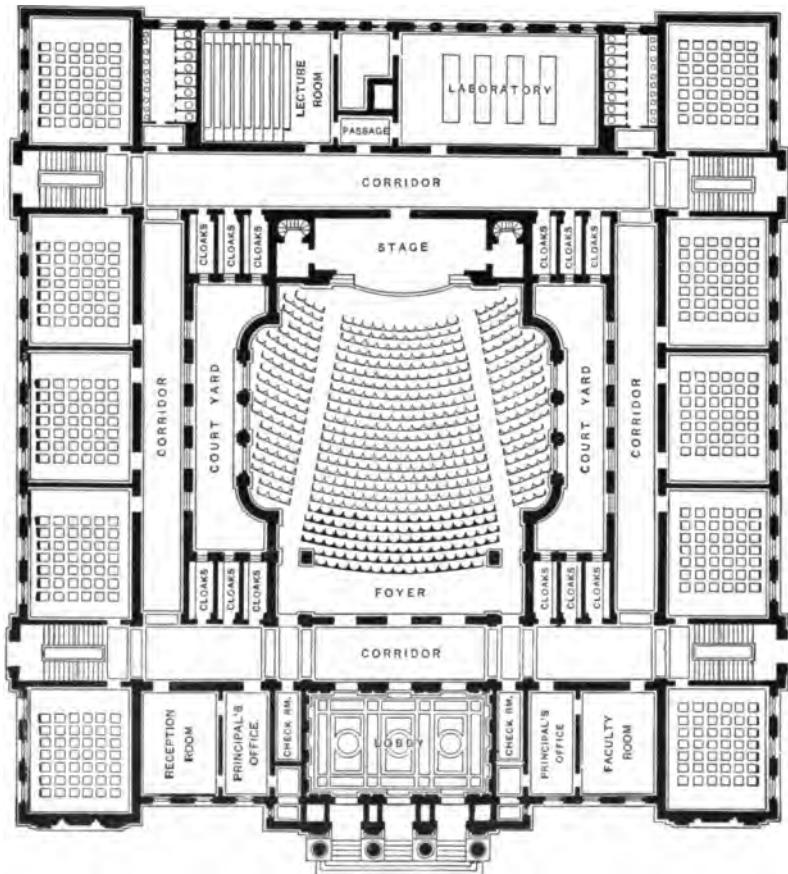
McKINLEY HIGH SCHOOL, ST. LOUIS. TOP-FLOOR AND TOWER PLAN.



EASTERN HIGH SCHOOL FOR GIRLS, BALTIMORE, MD.



EASTERN HIGH SCHOOL FOR GIRLS, BALTIMORE. BASEMENT PLAN.



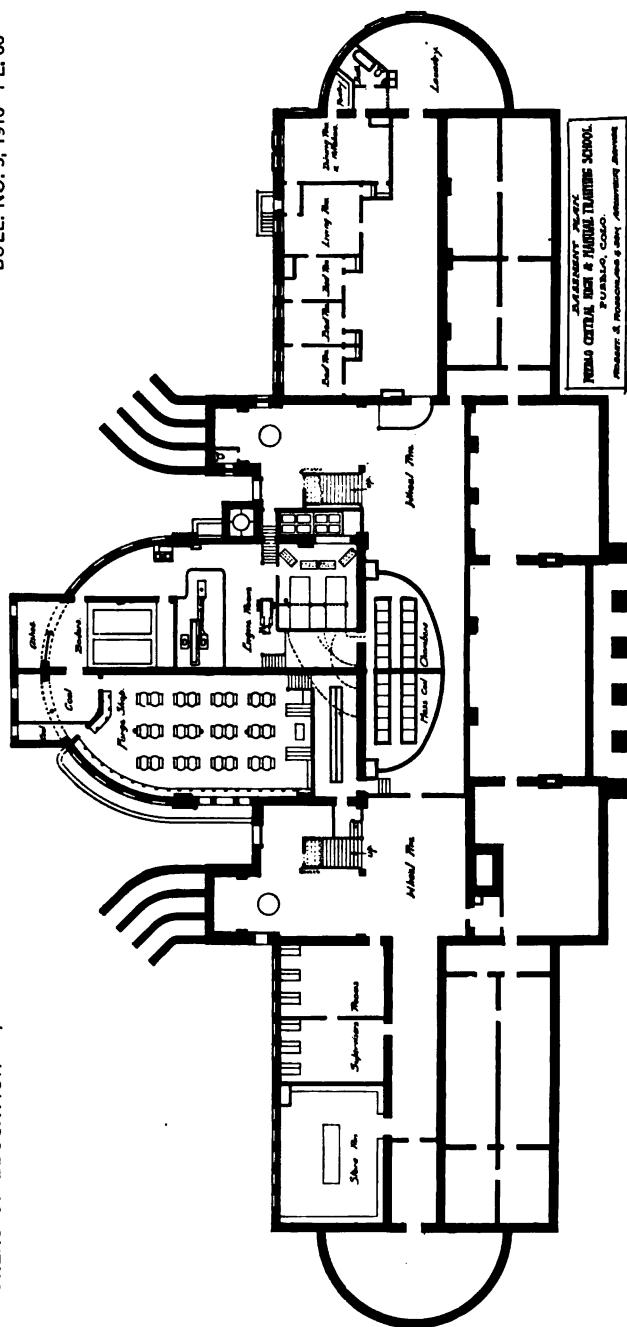
EASTERN HIGH SCHOOL FOR GIRLS, BALTIMORE. FLOOR PLAN.



EASTERN HIGH SCHOOL, DETROIT, MICH. MALCOMSON & HIGGINBOTHAM, ARCHITECTS.

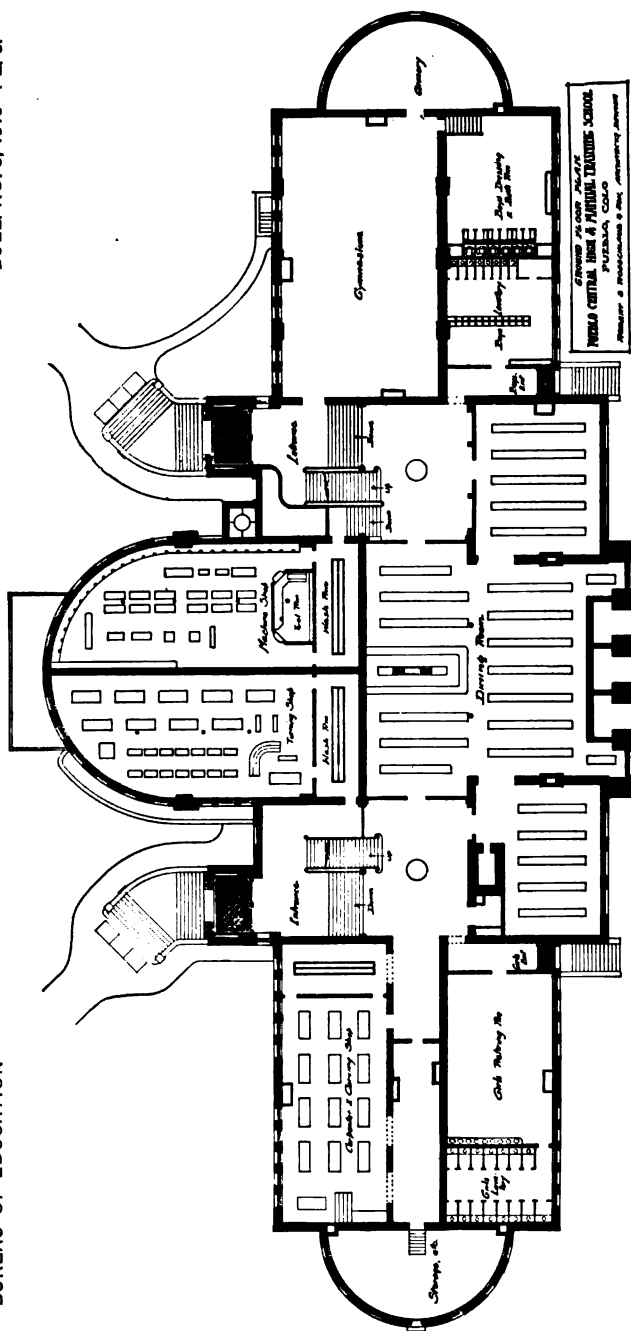


HIGH SCHOOL, DISTRICT NO. 20, PUEBLO, COLO. ROBERT T. ROESCHLAUB & SON, ARCHITECTS.

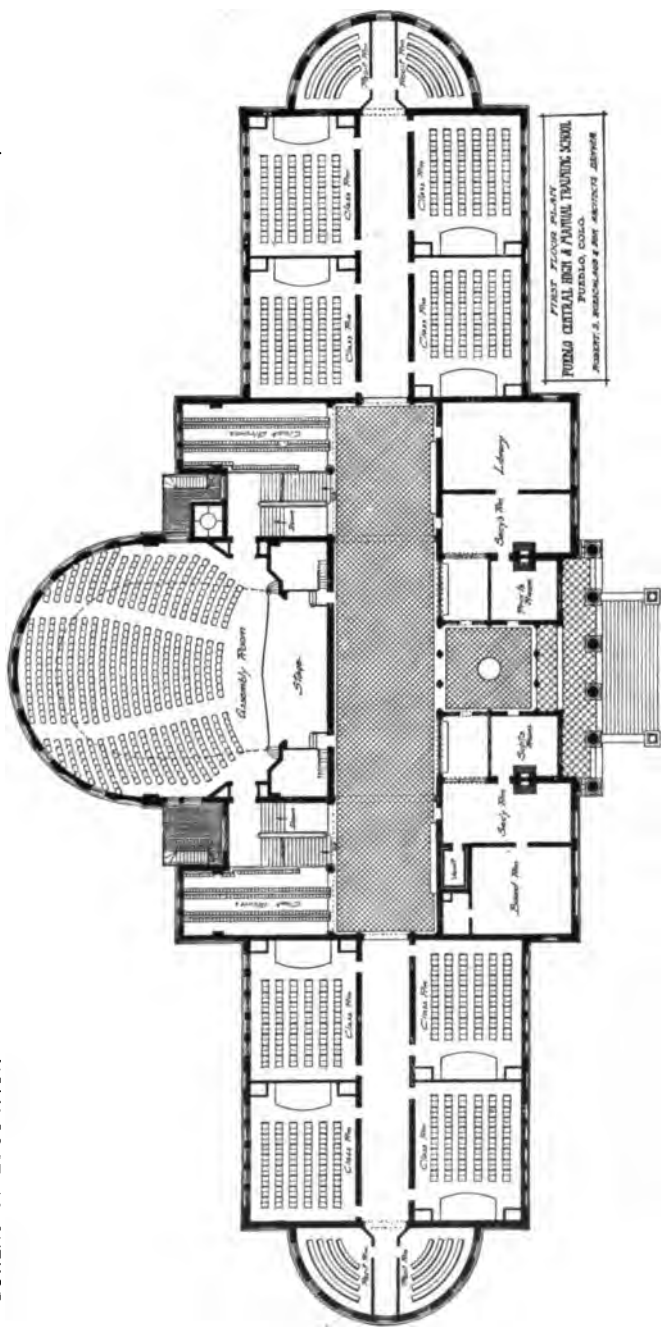


HIGH SCHOOL, DISTRICT NO. 20, PUEBLO, COLO. BASEMENT PLAN.

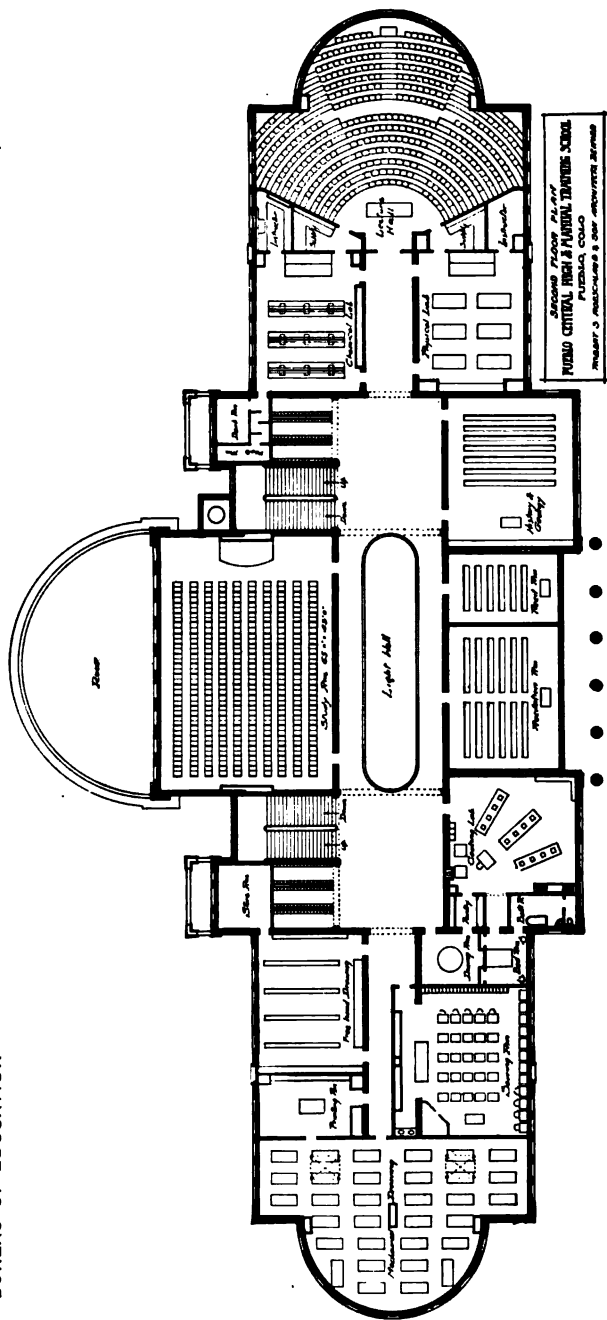




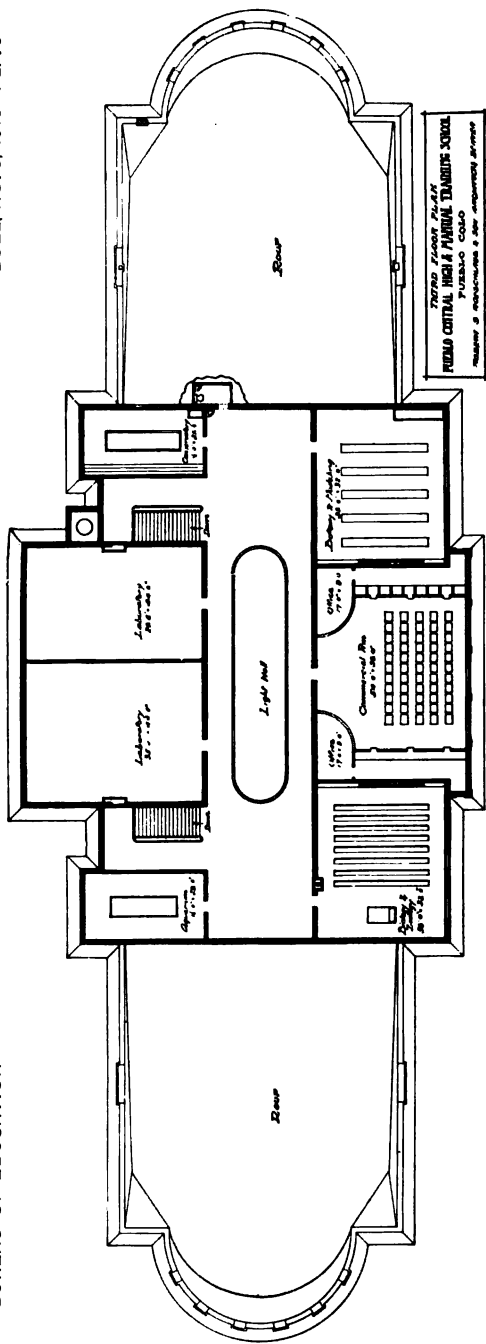
**HIGH SCHOOL, DISTRICT NO. 20, PUEBLO, COLO. GROUND-FLOOR PLAN.**



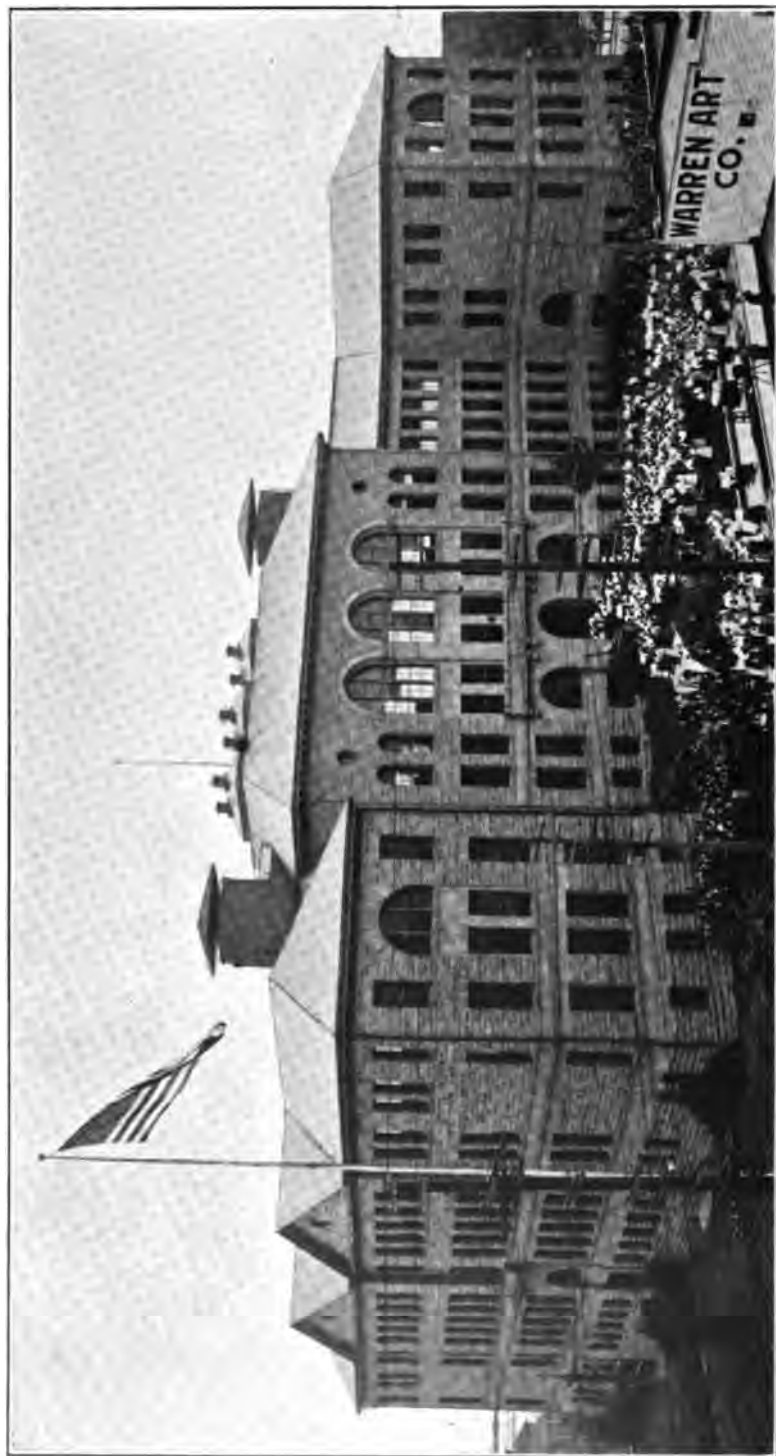
HIGH SCHOOL, DISTRICT NO. 20, PUEBLO, COLO. FIRST-FLOOR PLAN.



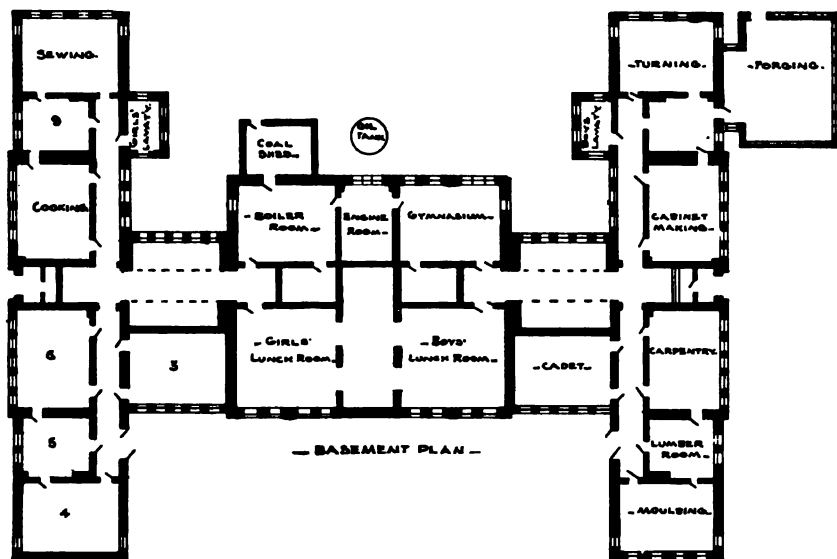
HIGH SCHOOL, DISTRICT NO. 20, PUEBLO, COLO. SECOND-FLOOR PLAN.



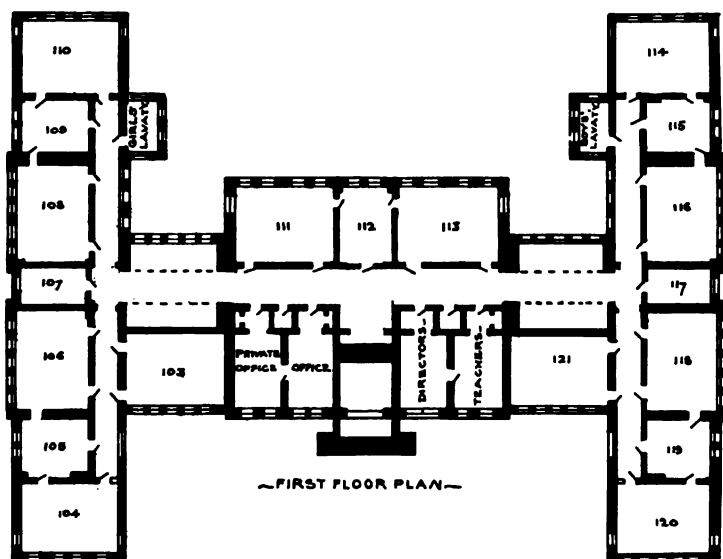
HIGH SCHOOL, DISTRICT NO. 20, PUEBLO, COLO. THIRD-FLOOR PLAN.



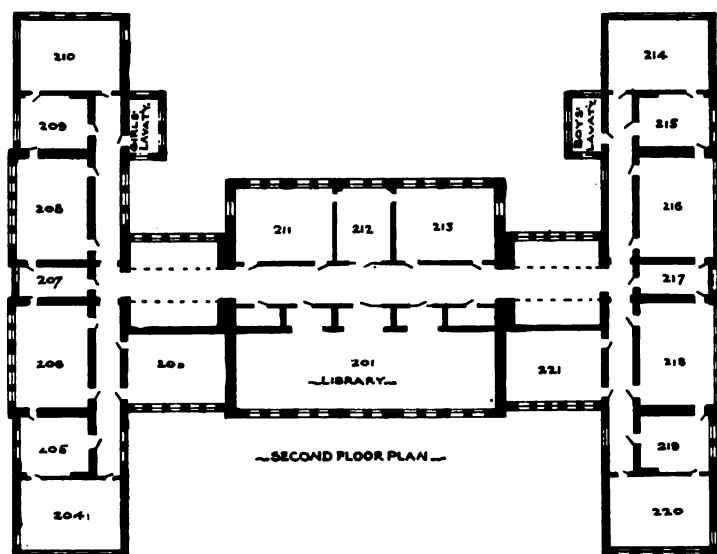
BROADWAY HIGH SCHOOL, SEATTLE, WASH.



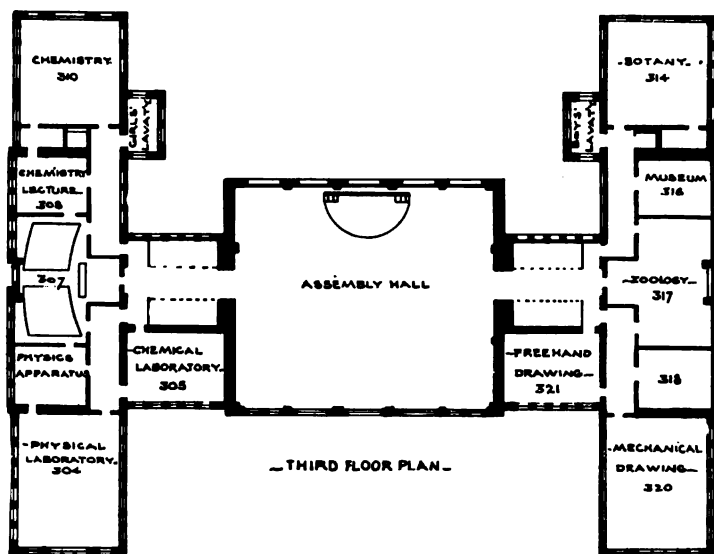
A. BROADWAY HIGH SCHOOL, SEATTLE. BASEMENT PLAN.



B. BROADWAY HIGH SCHOOL, SEATTLE. FIRST-FLOOR PLAN.



A. BROADWAY HIGH SCHOOL, SEATTLE. SECOND-FLOOR PLAN.



B. BROADWAY HIGH SCHOOL, SEATTLE. THIRD-FLOOR PLAN.

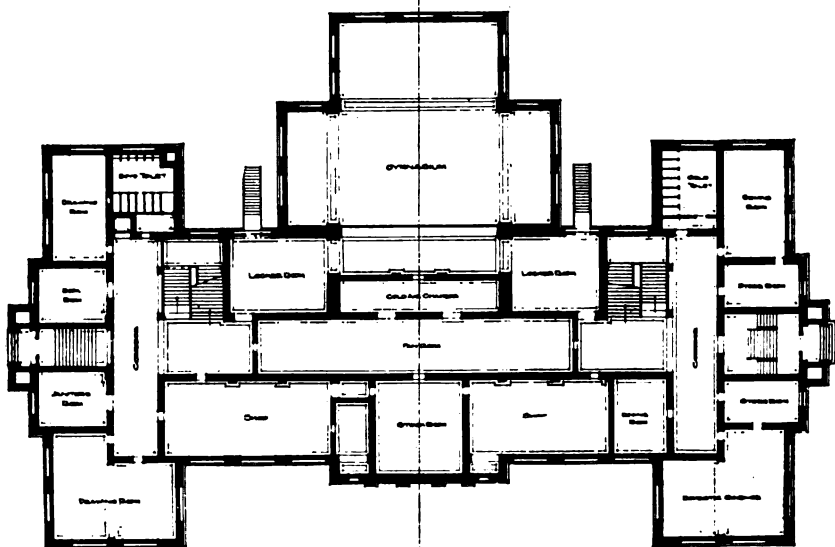


QUEEN ANNE HIGH SCHOOL, SEATTLE, WASH.





— FIRST FLOOR PLAN —

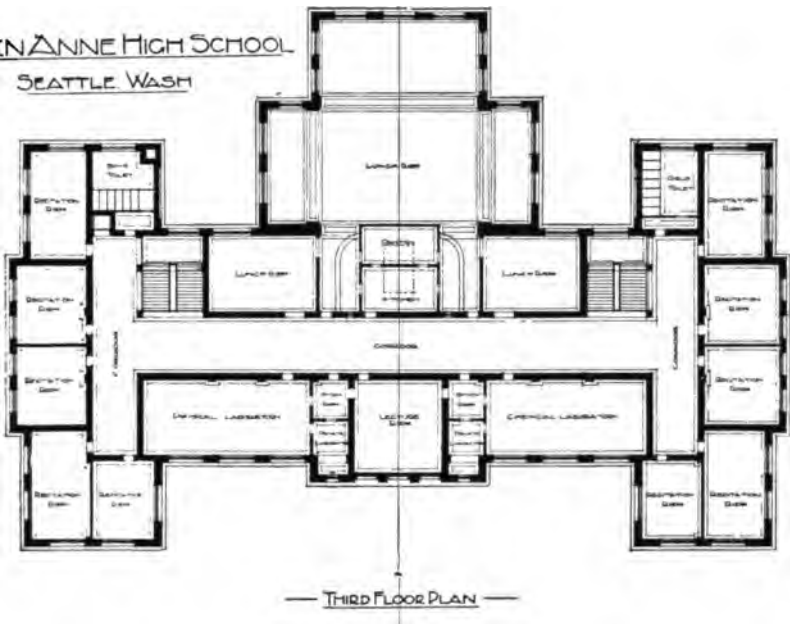


— BASEMENT PLAN —

A. QUEEN ANNE HIGH SCHOOL, SEATTLE. FIRST-FLOOR PLAN.

B. QUEEN ANNE HIGH SCHOOL, SEATTLE. BASEMENT PLAN.

**QUEEN ANNE HIGH SCHOOL**  
SEATTLE, WASH



A. QUEEN ANNE HIGH SCHOOL, SEATTLE. THIRD-FLOOR PLAN.



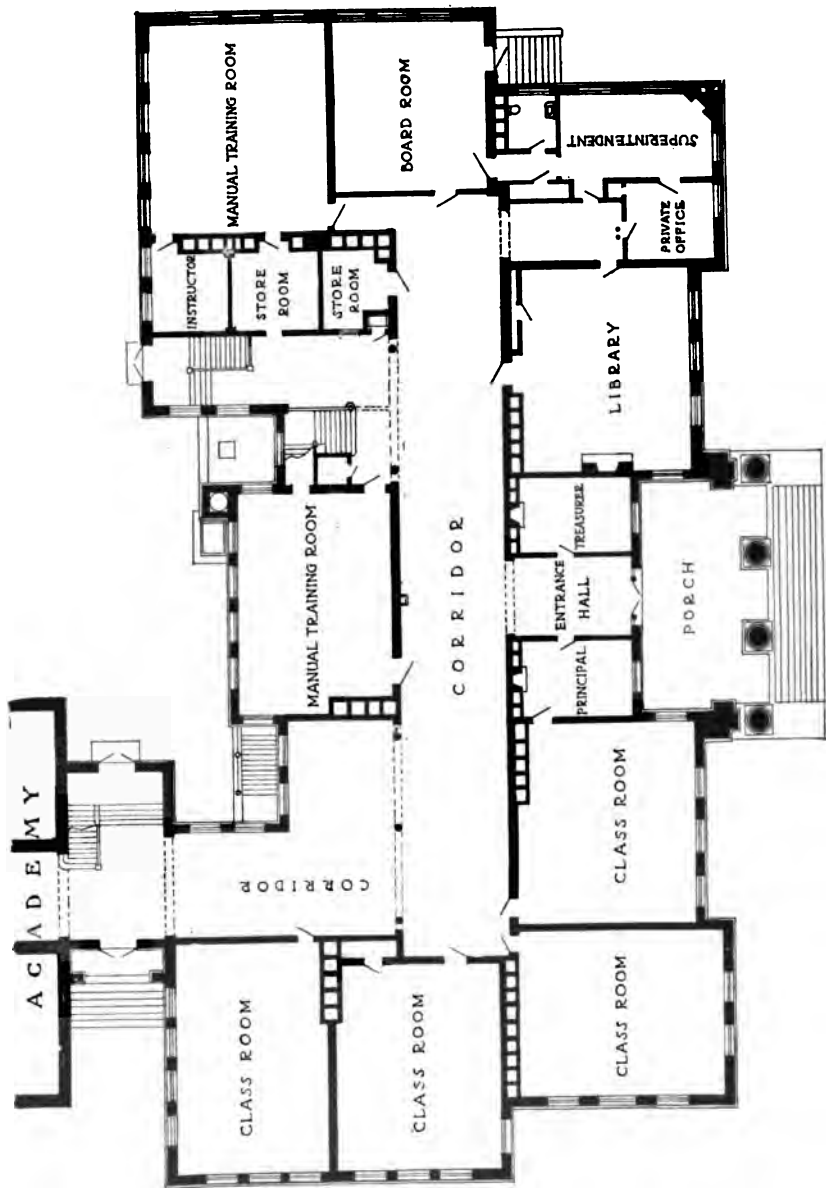
B. QUEEN ANNE HIGH SCHOOL, SEATTLE. BIOLOGICAL LABORATORY.



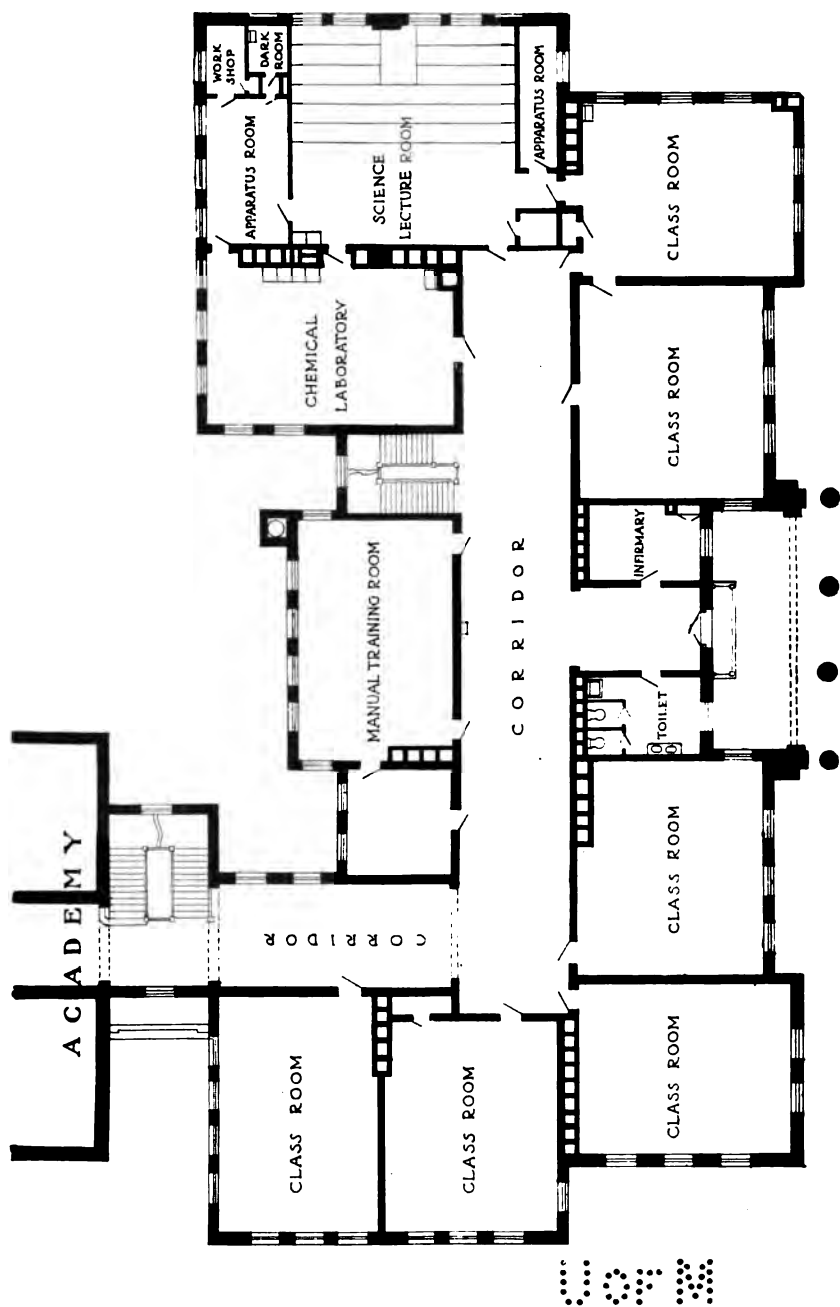
SAVANNAH (GA.) HIGH SCHOOL. OWENS & SISCO, ARCHITECTS.



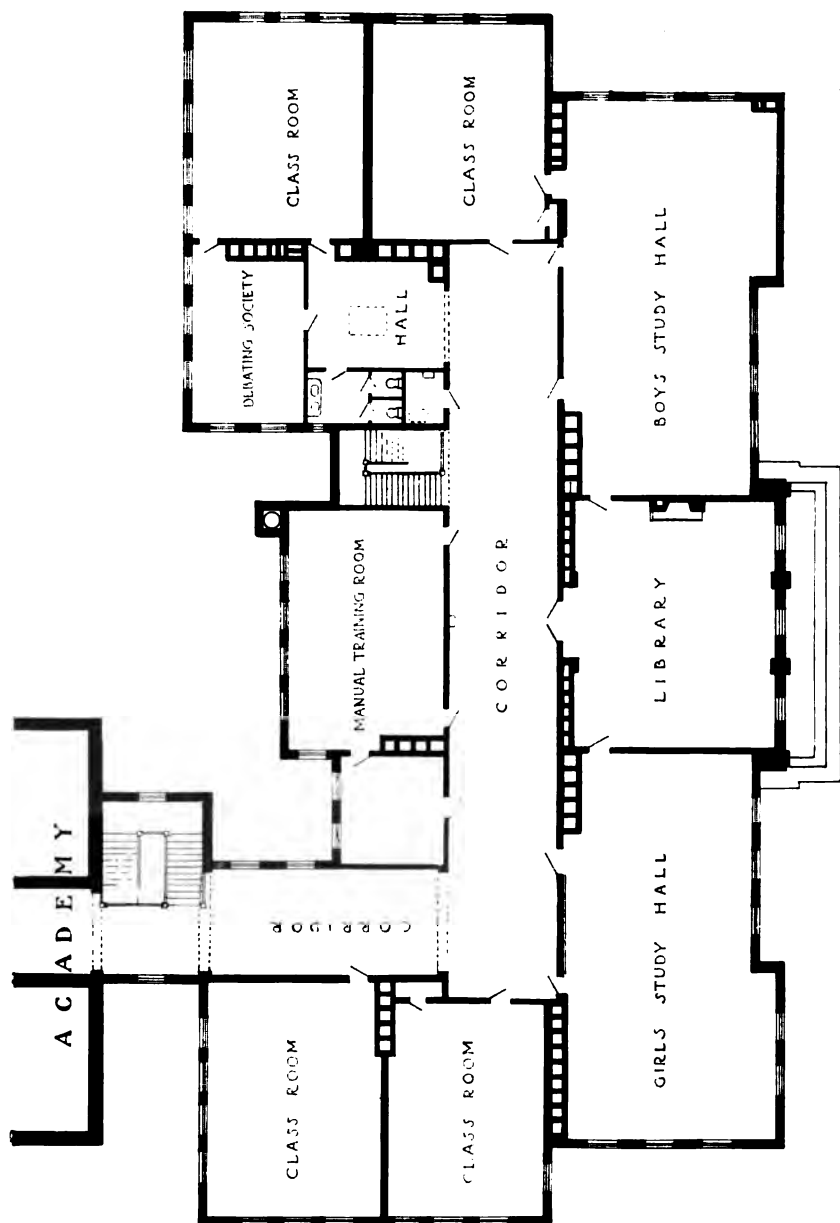
SAVANNAH HIGH SCHOOL. BASEMENT PLAN.



SAVANNAH HIGH SCHOOL. FIRST-FLOOR PLAN.



SAVANNAH HIGH SCHOOL. SECOND-FLOOR PLAN.

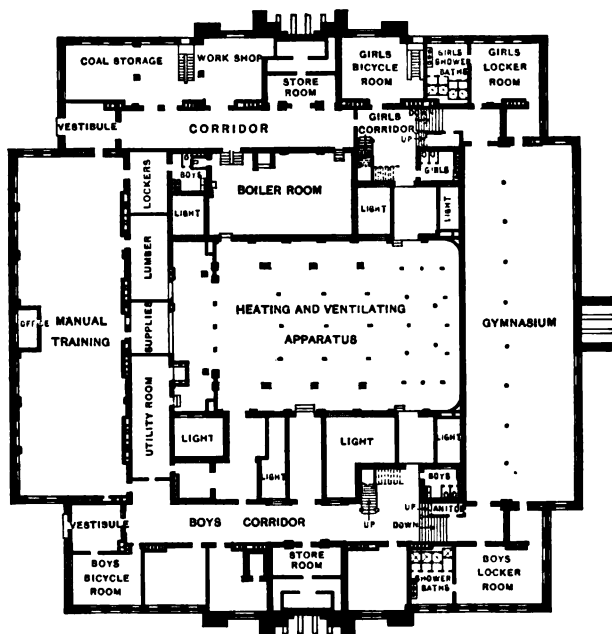


SAVANNAH HIGH SCHOOL. THIRD-FLOOR PLAN.

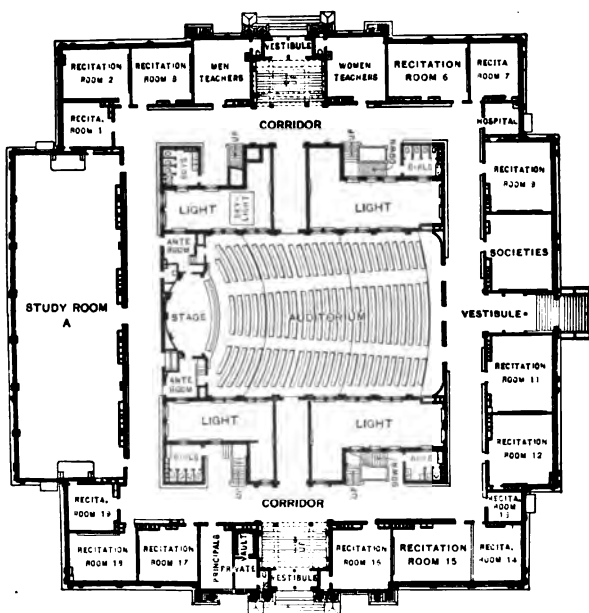


DAVENPORT (IOWA) HIGH SCHOOL. T. G. CLAUSEN AND P. T. BURROWS, ARCHITECTS.

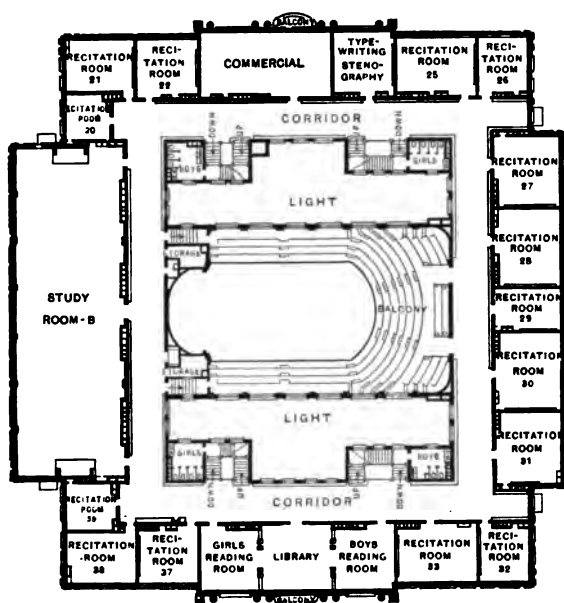




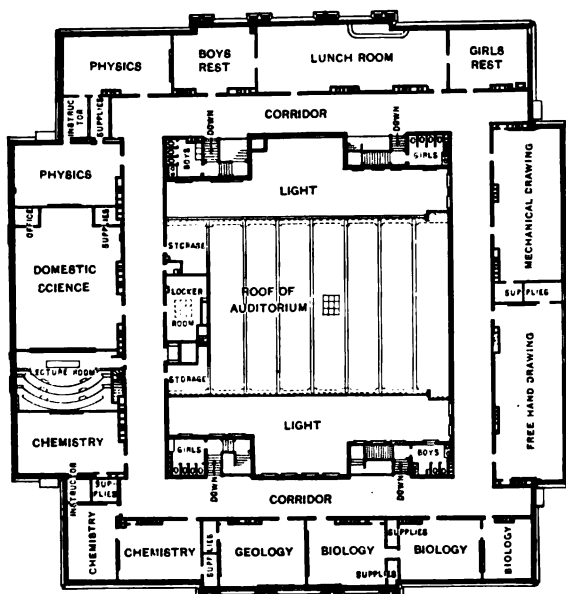
A. DAVENPORT HIGH SCHOOL. BASEMENT PLAN.



B. DAVENPORT HIGH SCHOOL. FIRST-FLOOR PLAN.



A. DAVENPORT HIGH SCHOOL. SECOND-FLOOR PLAN.



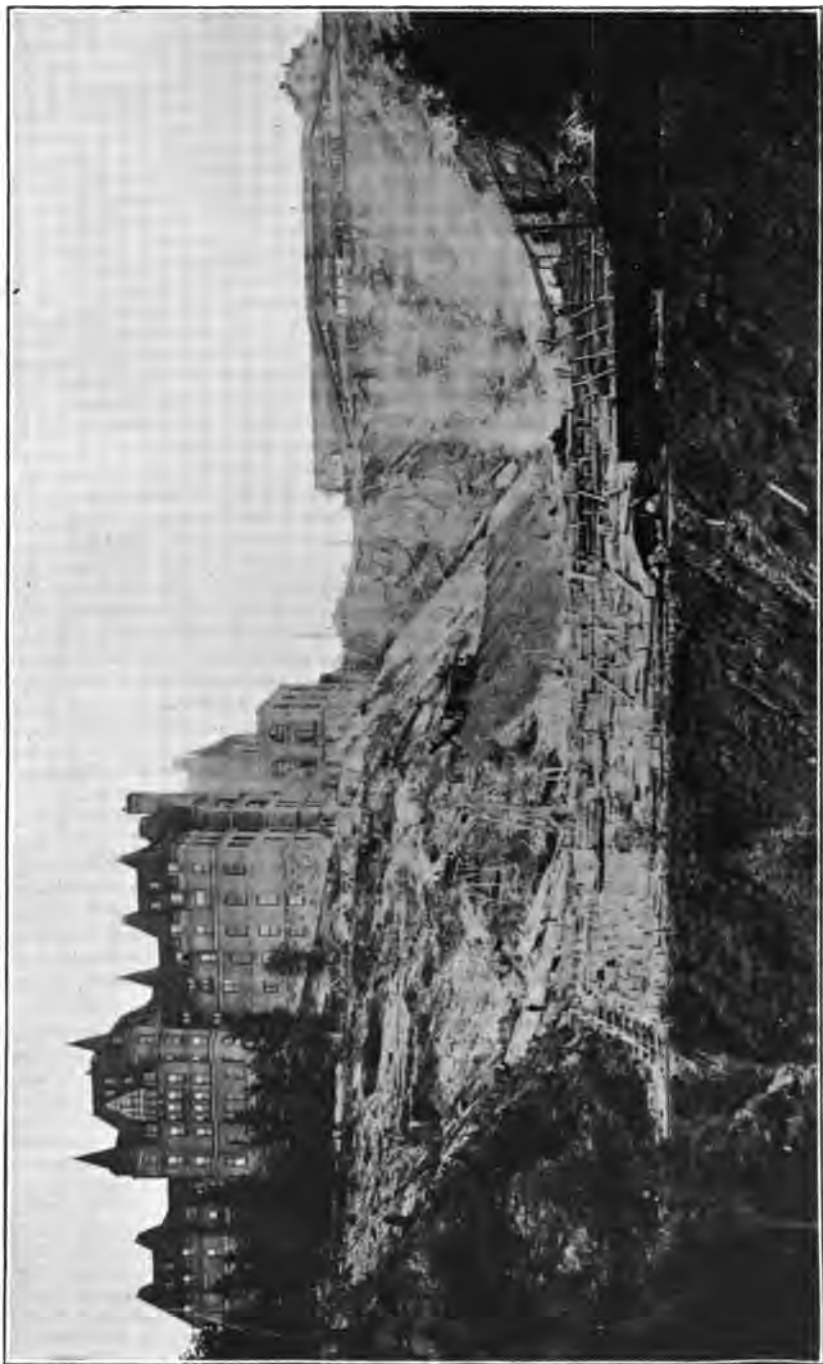
B. DAVENPORT HIGH SCHOOL. THIRD-FLOOR PLAN.



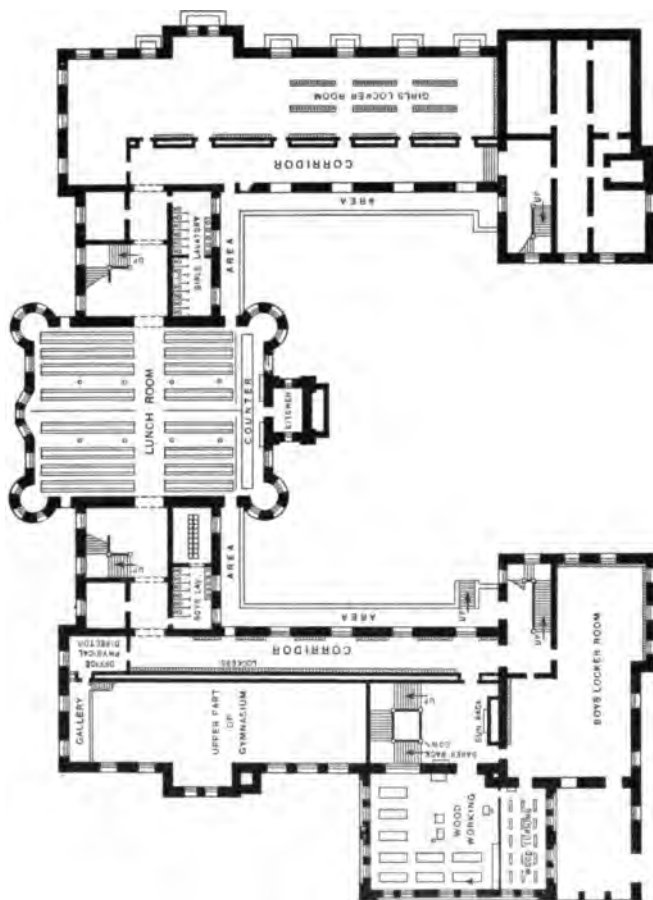
**A. POLYTECHNIC ELEMENTARY SCHOOL, PASADENA, CAL. HUNT & GREY, ARCHITECTS.**



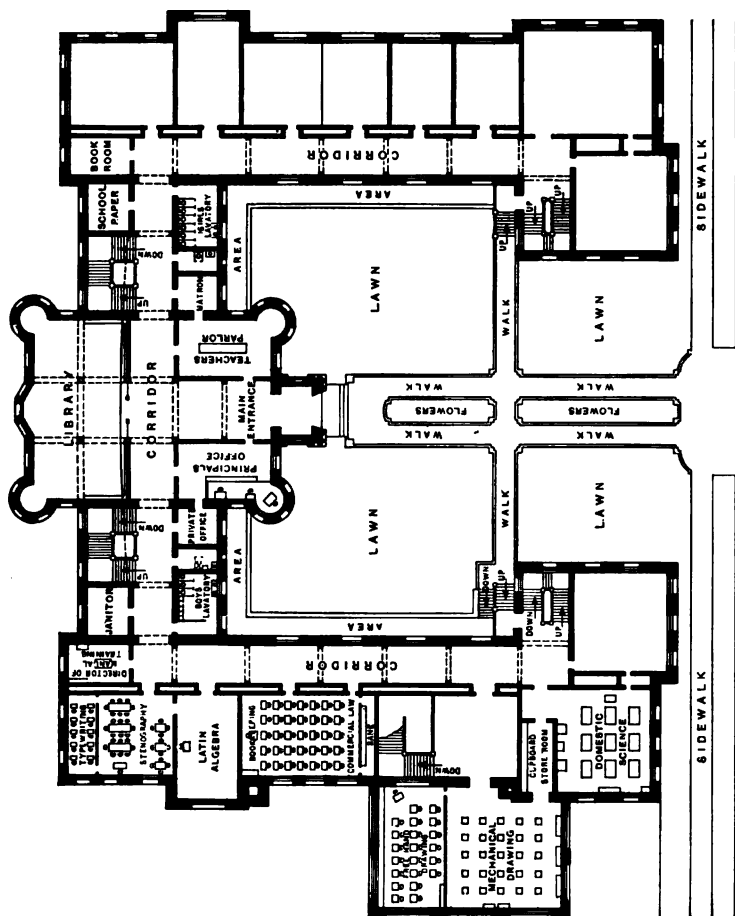
**B. POLYTECHNIC ELEMENTARY SCHOOL, PASADENA, CAL. ASSEMBLY ROOM.  
(FOR DESCRIPTION AND FLOOR PLAN SEE APPENDIX B, PAGE 121.)**



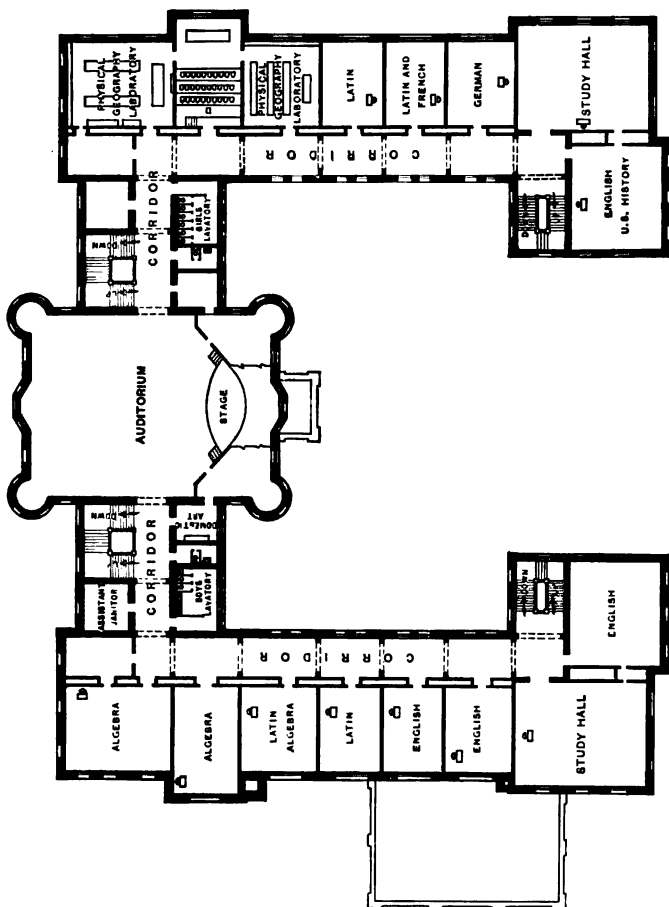
TACOMA (WASH.) HIGH SCHOOL. FREDERICK HEATH, ARCHITECT. EXCAVATING FOR A GREAT STADIUM AND ATHLETIC FIELD.



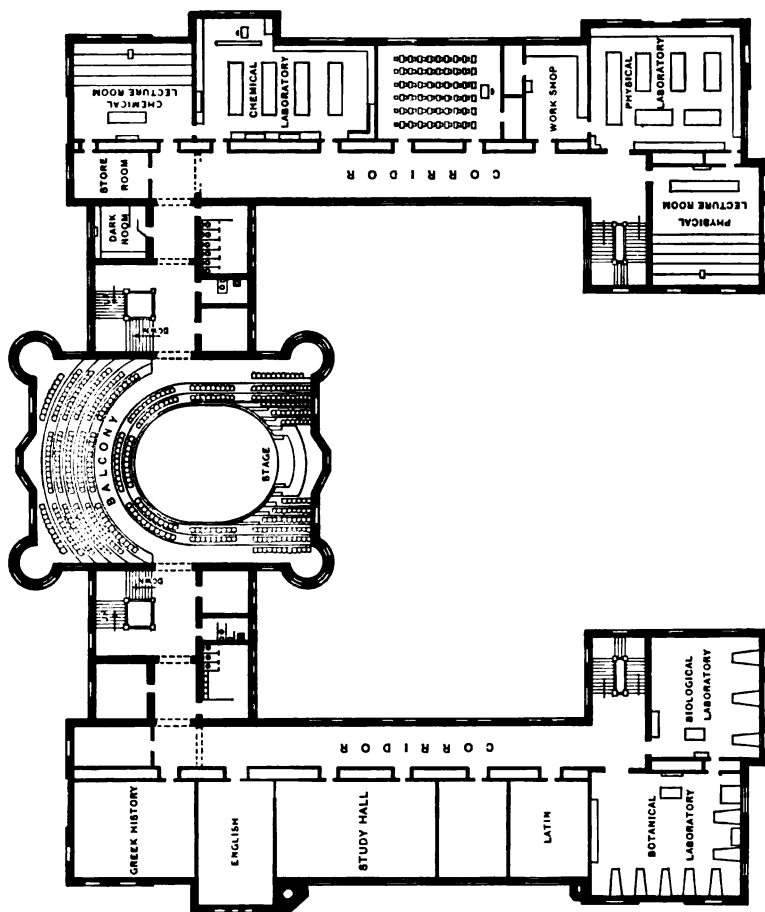
TACOMA HIGH SCHOOL. BASEMENT PLAN.



TACOMA HIGH SCHOOL. FIRST-FLOOR PLAN.

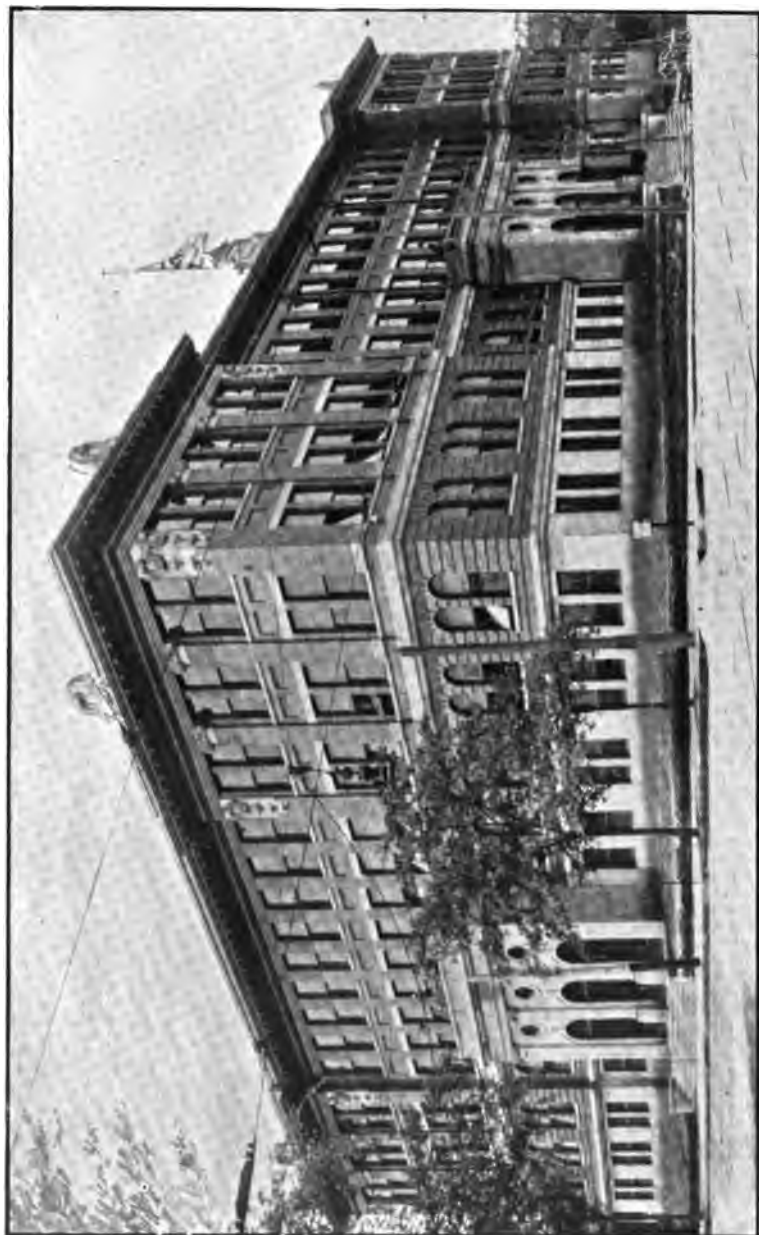


TACOMA HIGH SCHOOL. SECOND-FLOOR PLAN.



TACOMA HIGH SCHOOL. THIRD-FLOOR PLAN.





BIRMINGHAM (ALA.) HIGH SCHOOL.



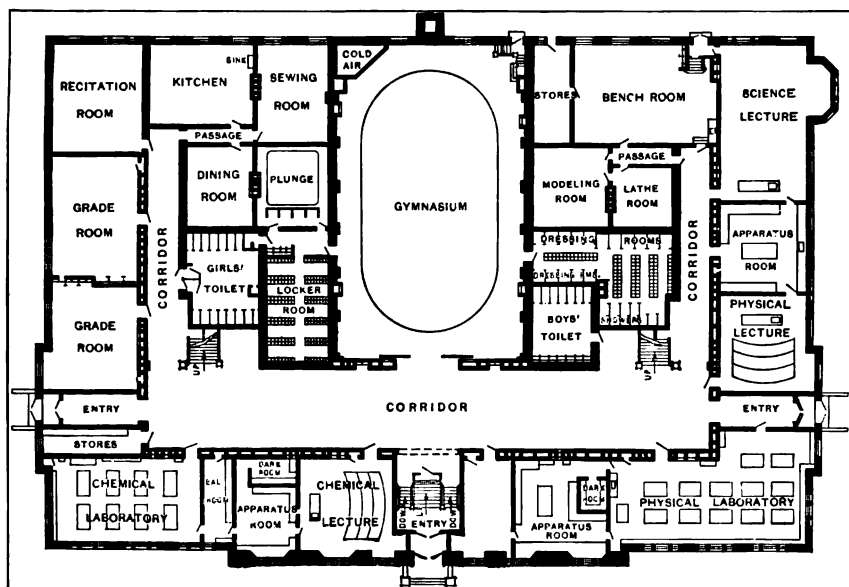
BIRMINGHAM HIGH SCHOOL. DOMESTIC-SCIENCE LABORATORY.



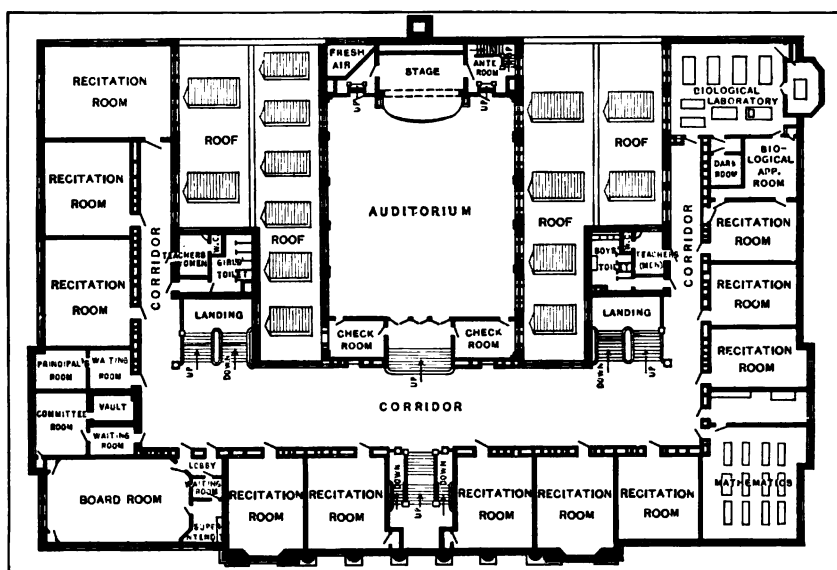
BIRMINGHAM HIGH SCHOOL, LUNCH ROOM.



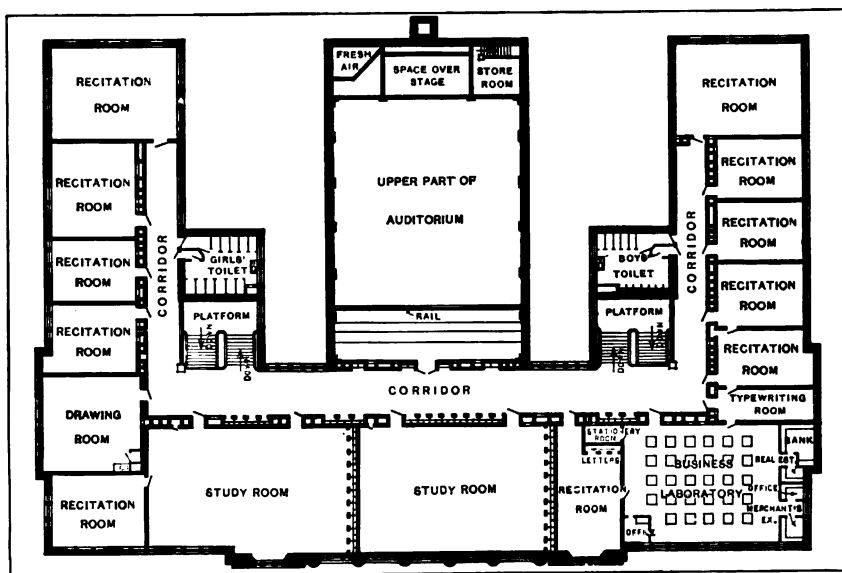
A. ANN ARBOR (MICH.) HIGH SCHOOL. MALCOMSON & HIGGINBOTHAM, ARCHITECTS.



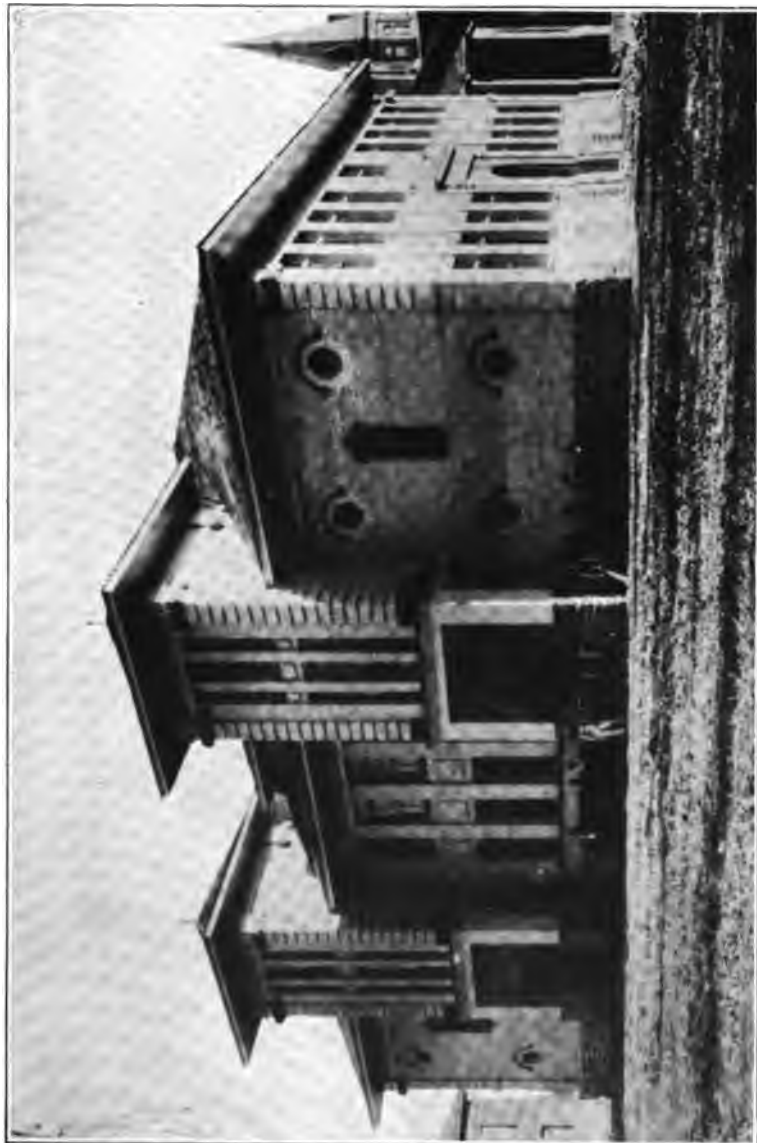
B. ANN ARBOR HIGH SCHOOL. GROUND-FLOOR PLAN.



A. ANN ARBOR HIGH SCHOOL. FIRST-FLOOR PLAN.



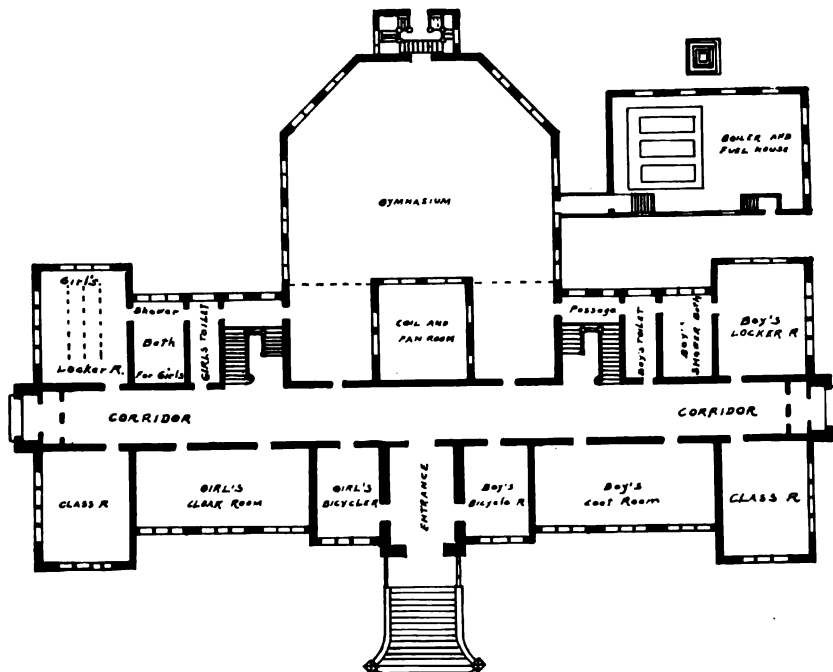
B. ANN ARBOR HIGH SCHOOL. SECOND-FLOOR PLAN.



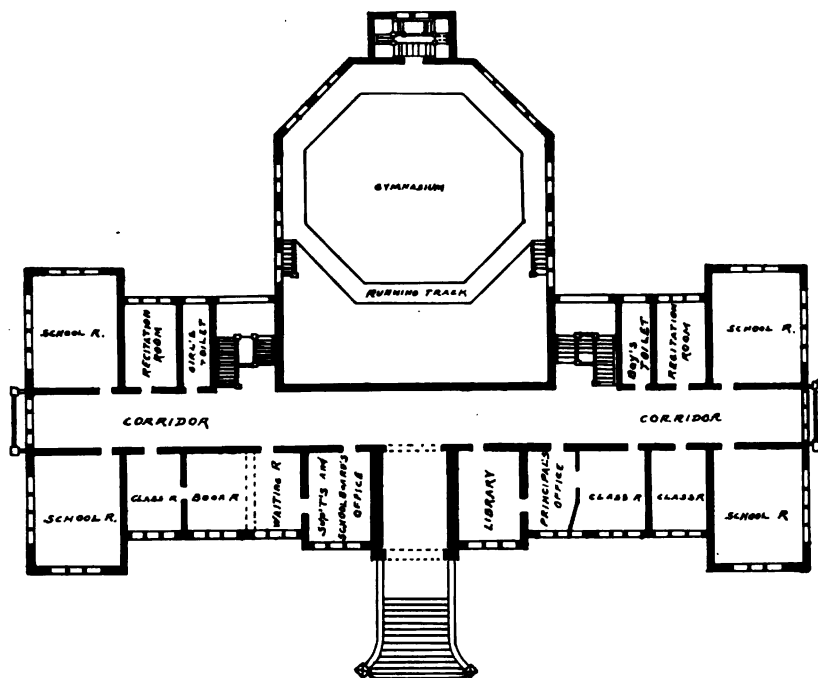
RICHFIELD (UTAH) HIGH SCHOOL.



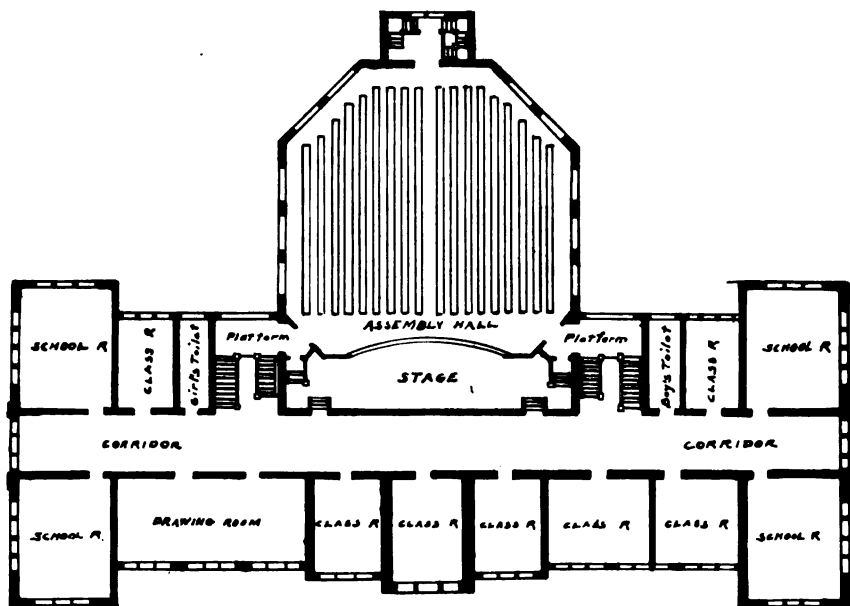
A. ASHLAND (WIS.) HIGH SCHOOL. HENRY WILDHAGEN, ARCHITECT.



B. ASHLAND HIGH SCHOOL. BASEMENT PLAN.



A. ASHLAND HIGH SCHOOL. FIRST-FLOOR PLAN.

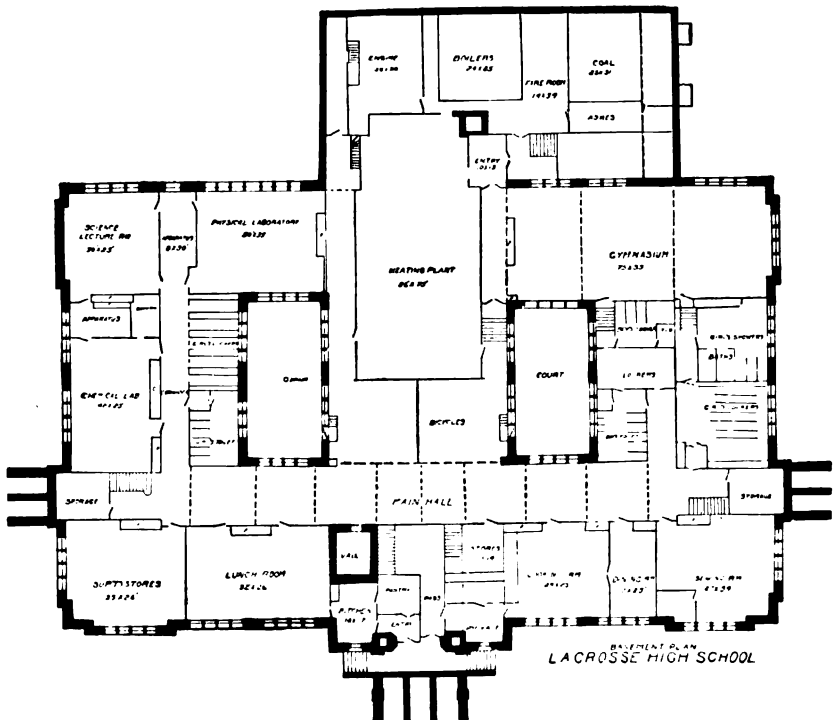


B. ASHLAND HIGH SCHOOL. SECOND-FLOOR PLAN.

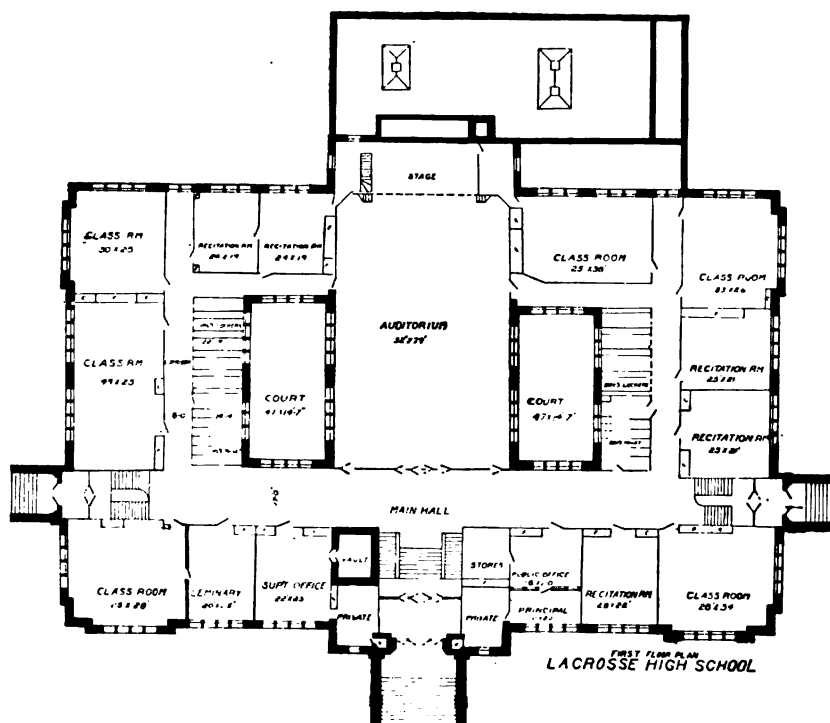




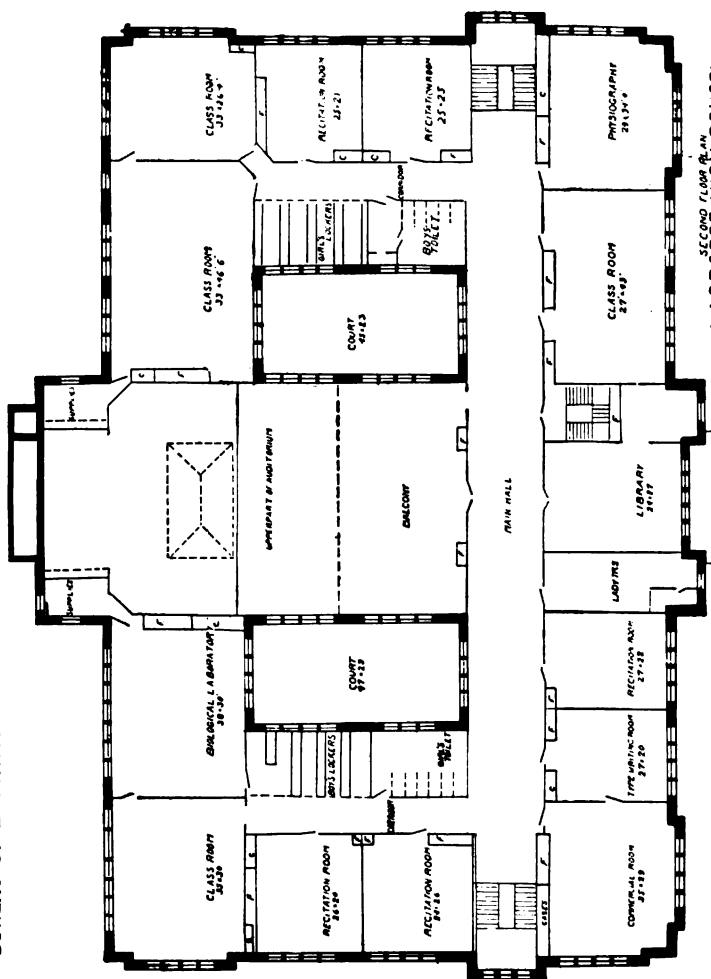
A. LA CROSSE (WIS.) HIGH SCHOOL.



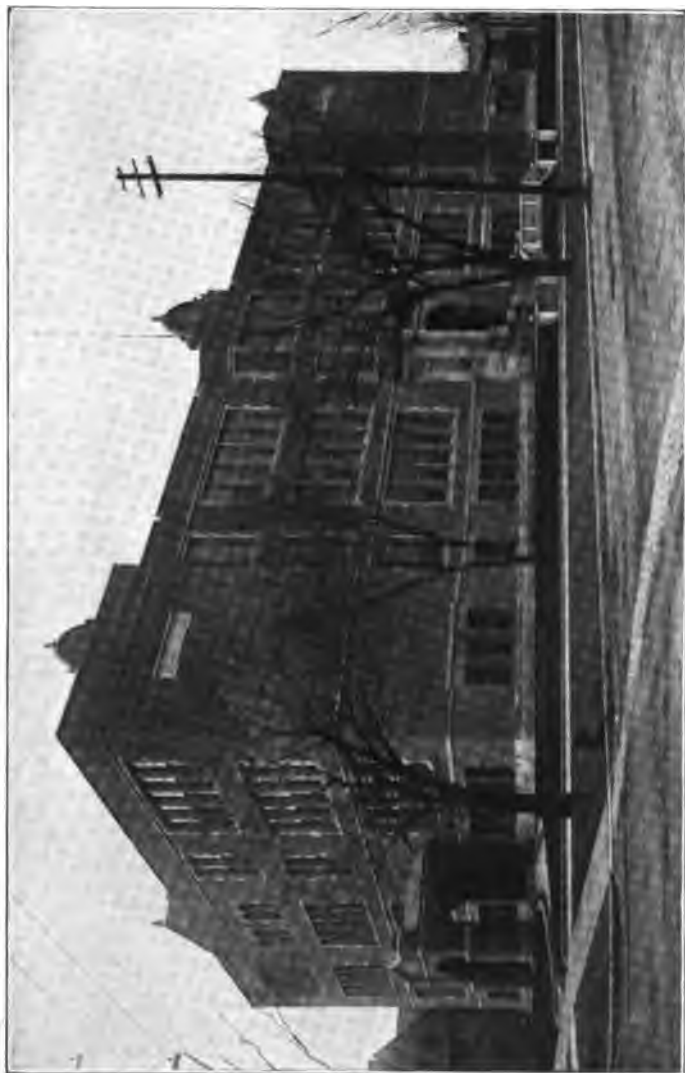
B. LA CROSSE HIGH SCHOOL. BASEMENT PLAN.



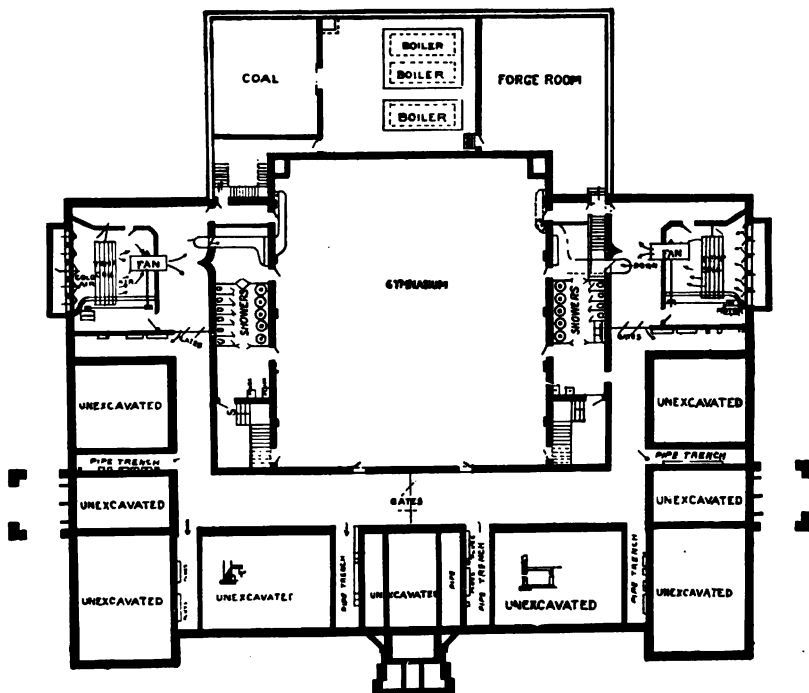
LA CROSSE HIGH SCHOOL. FIRST-FLOOR PLAN.



SECOND FLOOR PLAN  
LA CROSSE HIGH SCHOOL  
LA CROSSE HIGH SCHOOL SECOND-FLOOR PLAN.

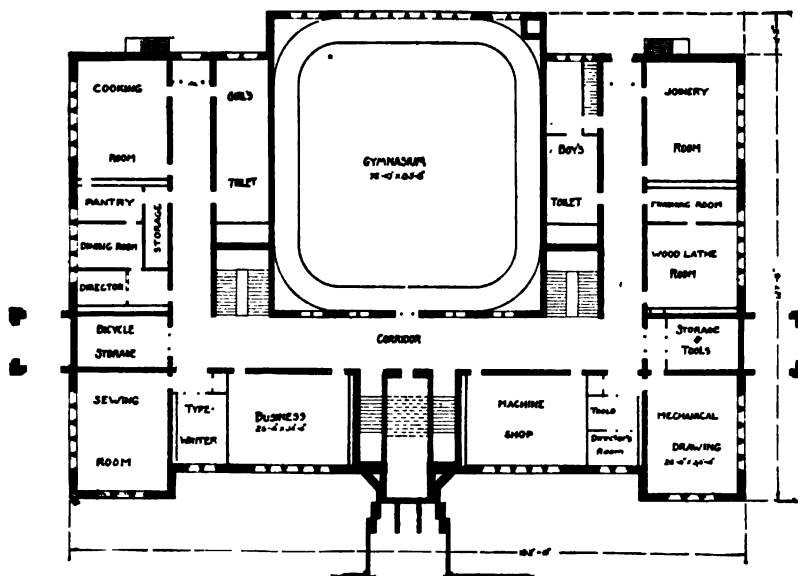


MADISON (WIS.) HIGH SCHOOL.

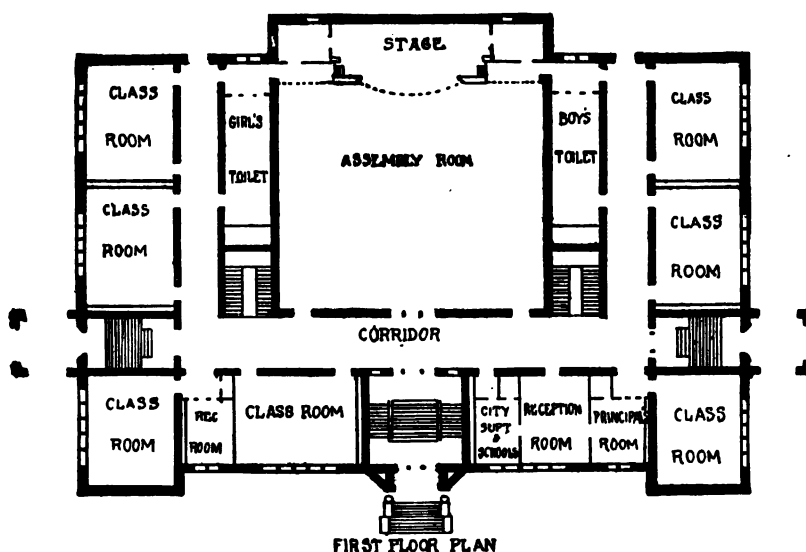


SKELETON—  
BASEMENT PLAN  
MADISON HIGH SCHOOL, MADISON WIS.  
SCALE 5'-10"

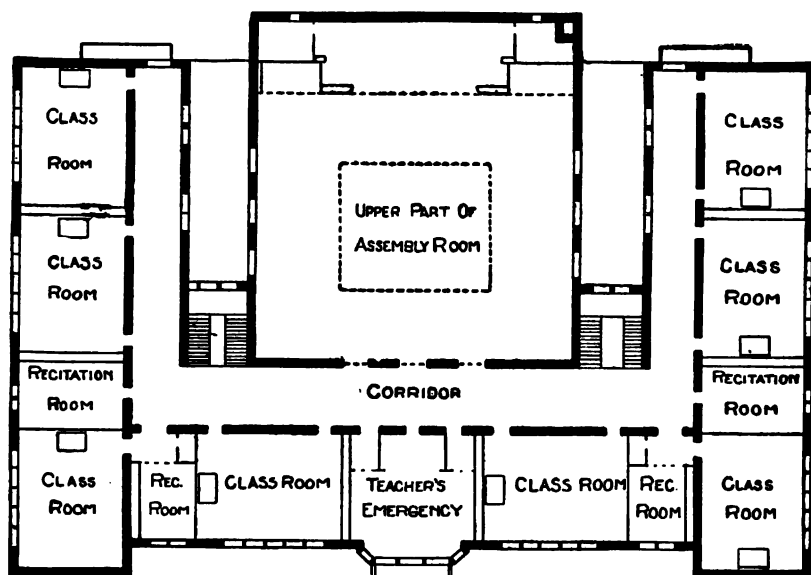
MADISON HIGH SCHOOL. BASEMENT PLAN.



A. MADISON HIGH SCHOOL. GROUND-FLOOR PLAN.

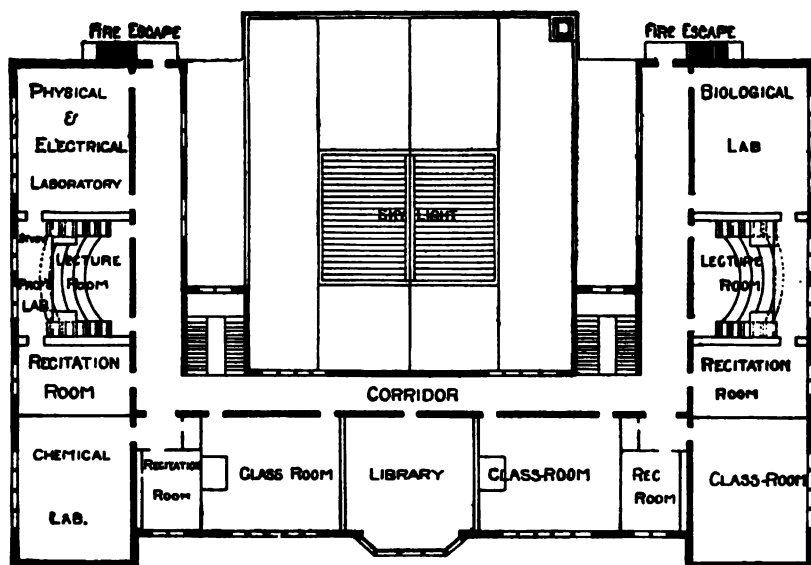


B. MADISON HIGH SCHOOL. FIRST-FLOOR PLAN.



SECOND FLOOR PLAN

A. MADISON HIGH SCHOOL. SECOND-FLOOR PLAN.



THIRD FLOOR PLAN

B. MADISON HIGH SCHOOL. THIRD-FLOOR PLAN.

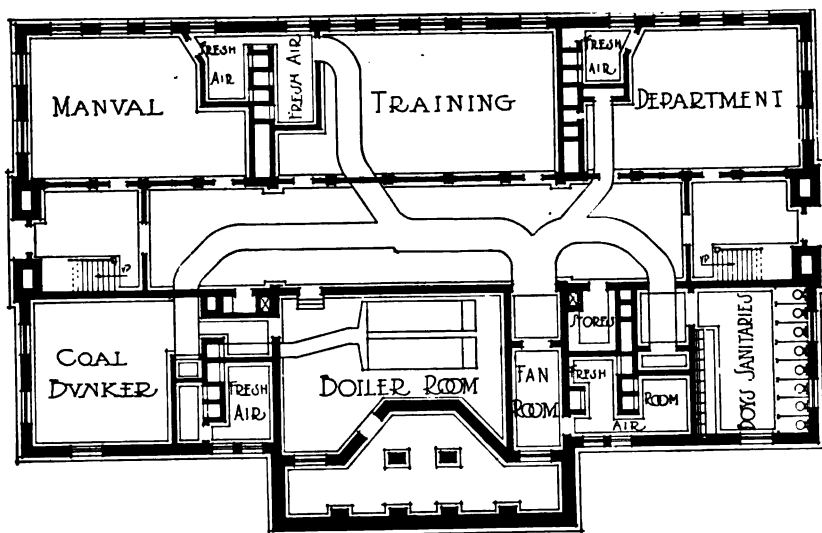


MADISON HIGH SCHOOL. FRONT CORRIDOR, FIRST FLOOR.

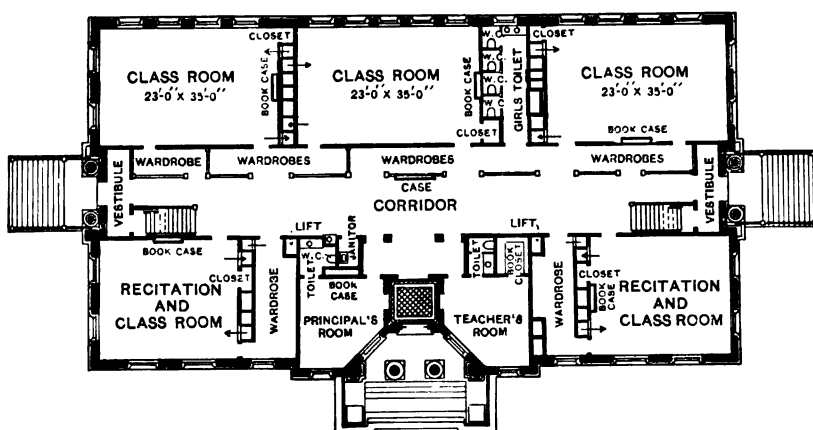




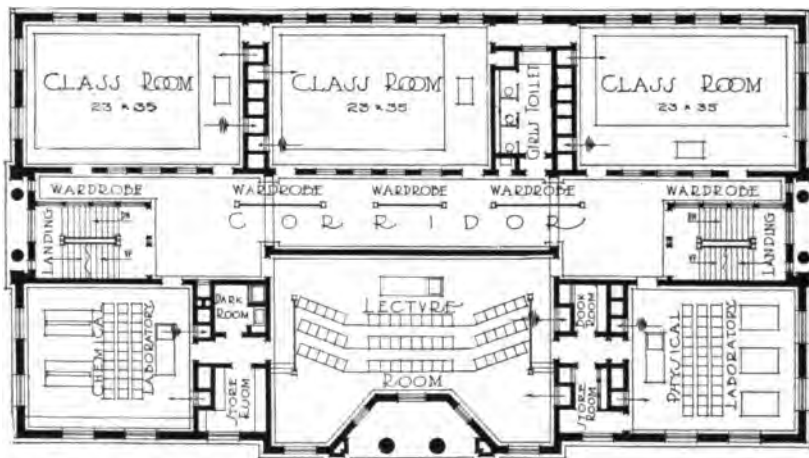
LEXINGTON (MASS.) HIGH SCHOOL. COOPER & BAILEY, ARCHITECTS. OCCUPIES THE SITE UPON WHICH LORD PERCY'S CANNON WERE PLACED TO COVER THE RETREAT OF THE BRITISH, APRIL 19, 1775.



A. LEXINGTON HIGH SCHOOL. BASEMENT PLAN.



B. LEXINGTON HIGH SCHOOL. FIRST-FLOOR PLAN.



A. LEXINGTON HIGH SCHOOL. SECOND-FLOOR PLAN.

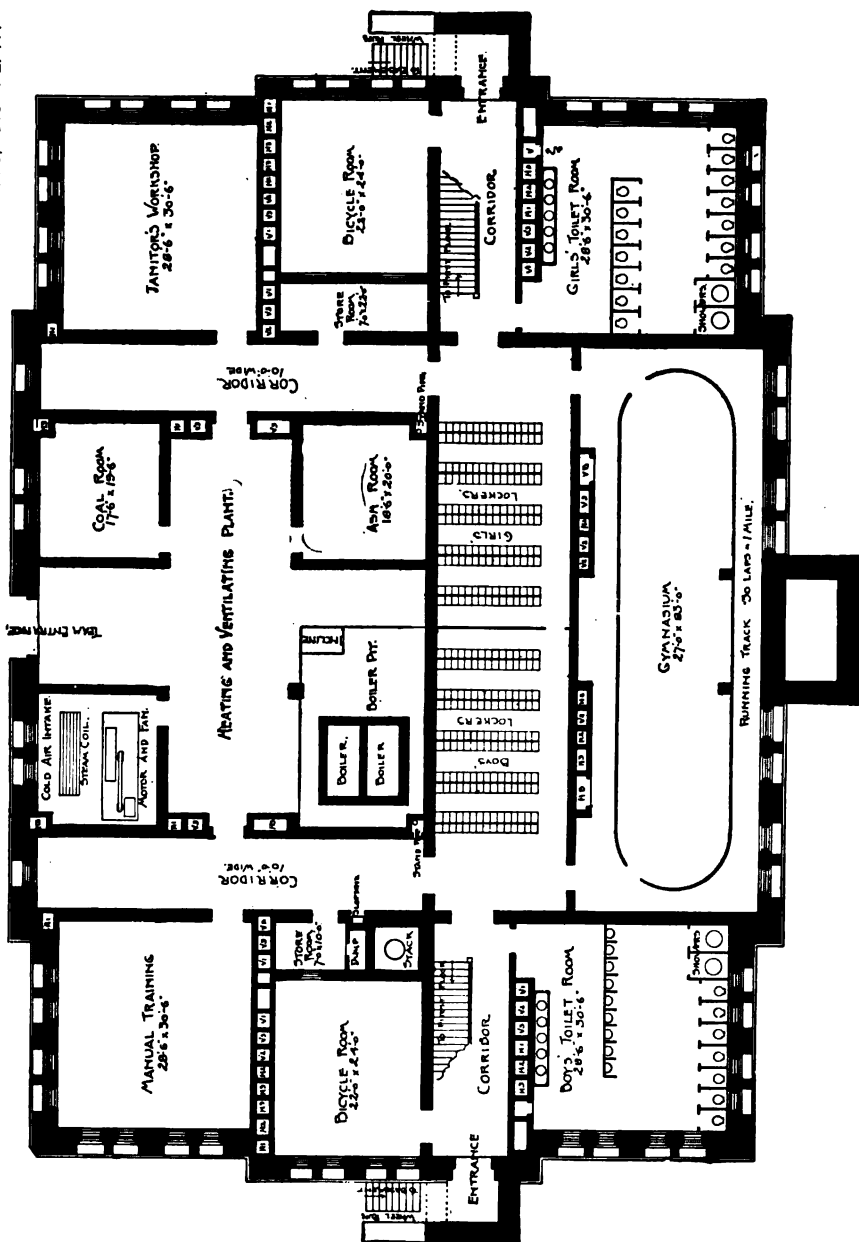


B. MALDEN (MASS.) HIGH SCHOOL. COOPER & BAILEY, ARCHITECTS. FOR FLOOR PLAN, SEE FIG. 3, PAGE 24.

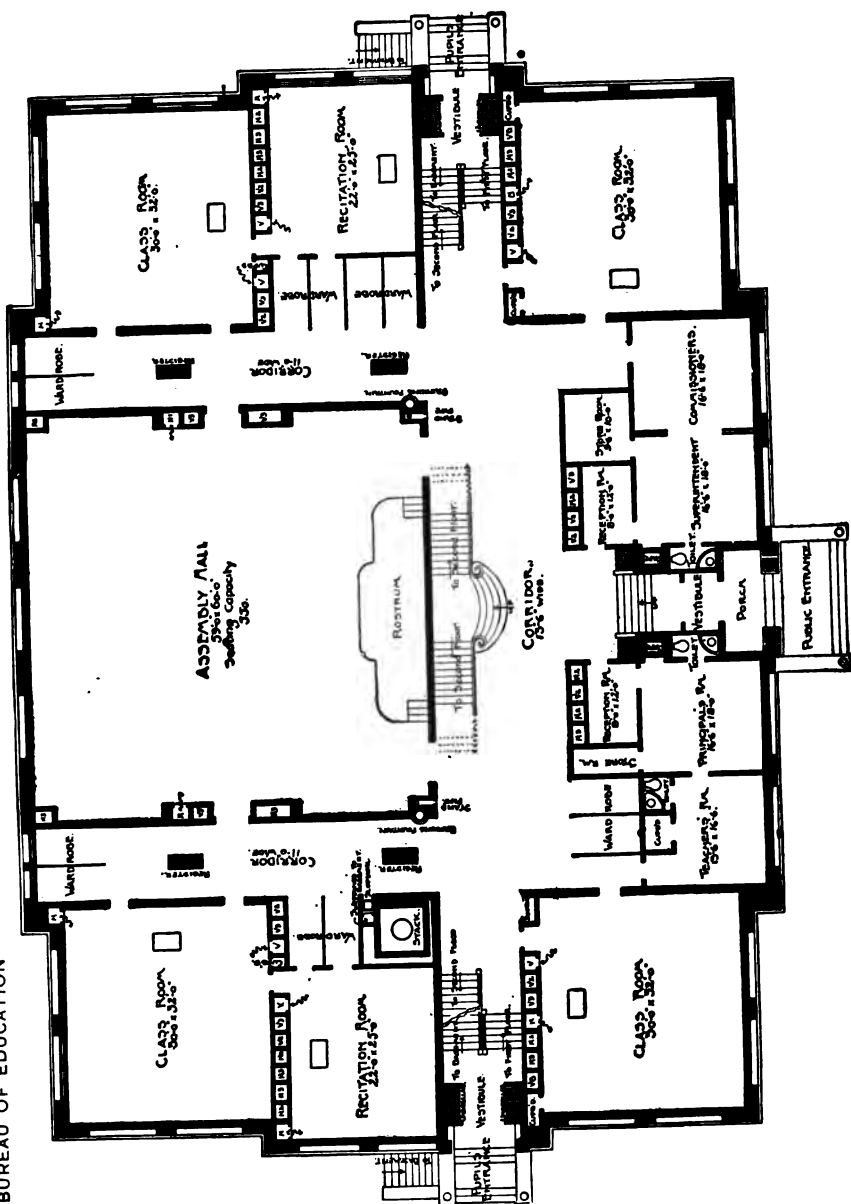


EDMUNDS HIGH SCHOOL, BURLINGTON, VT. A DIGNIFIED AND RESTFUL LOCATION.

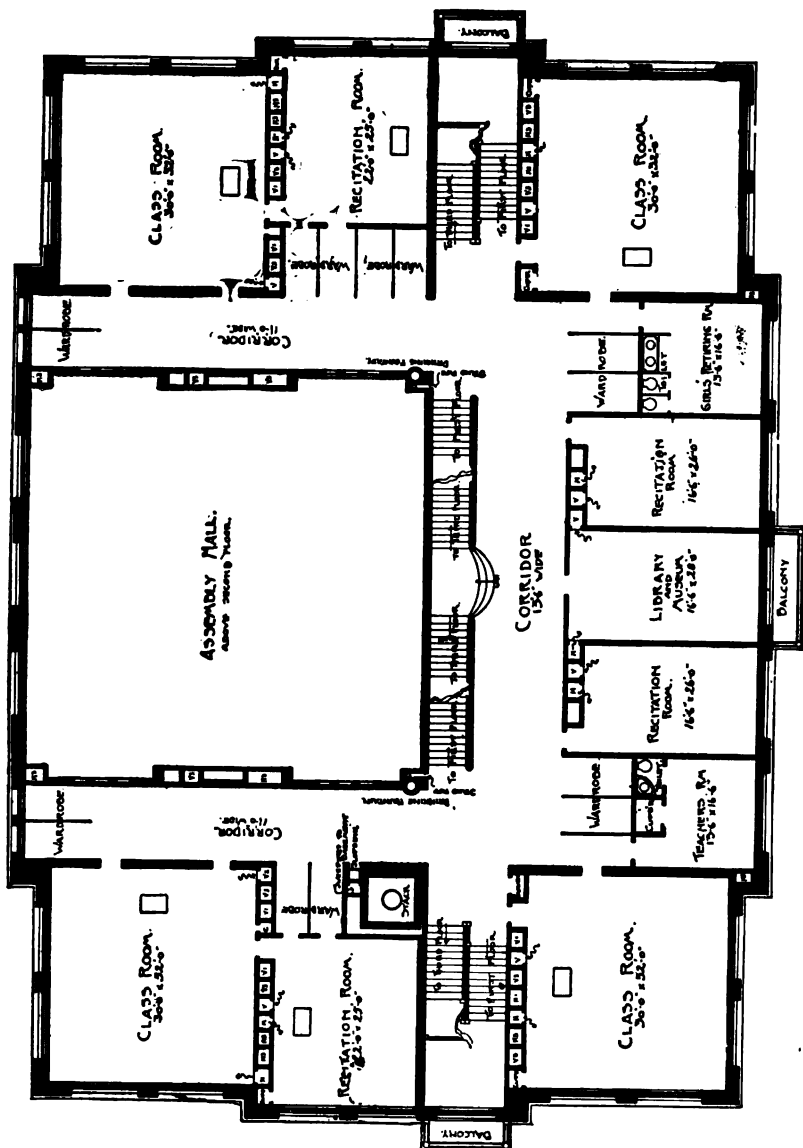
Digitized by Google



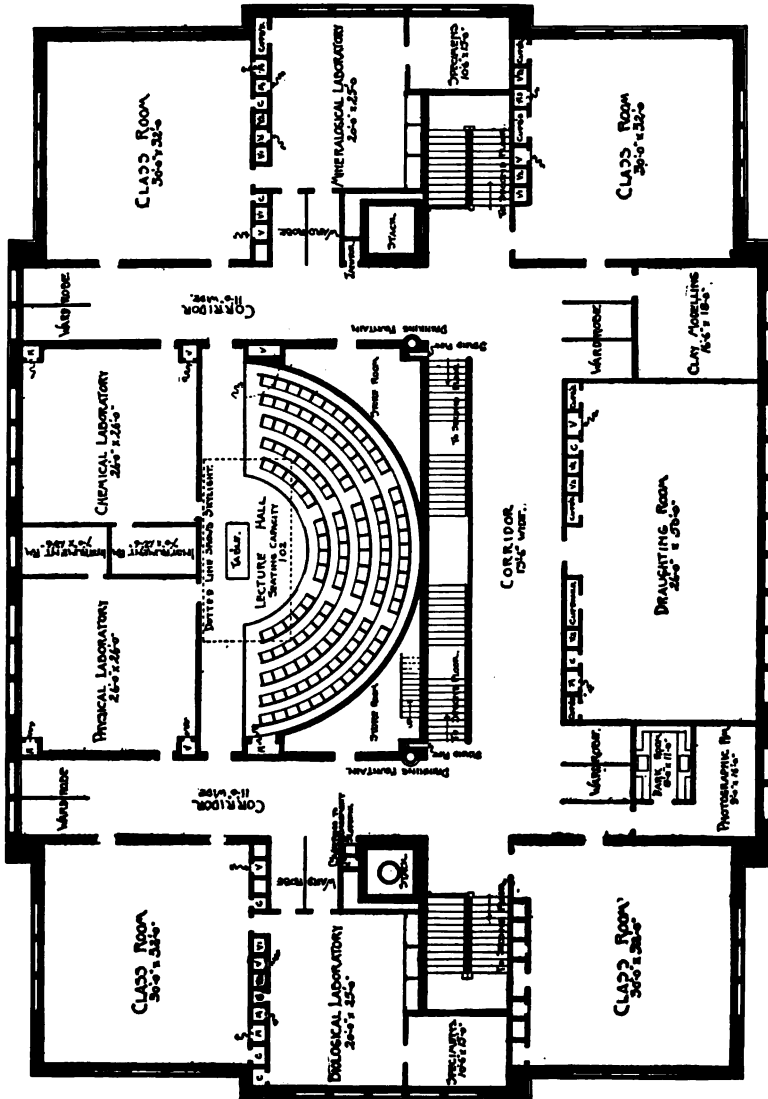
EDMUNDS (VT.) HIGH SCHOOL. BASEMENT PLAN. FOR EXTERIOR VIEW, SEE PLATE 110.



EDMUNDS HIGH SCHOOL. FIRST-FLOOR PLAN.

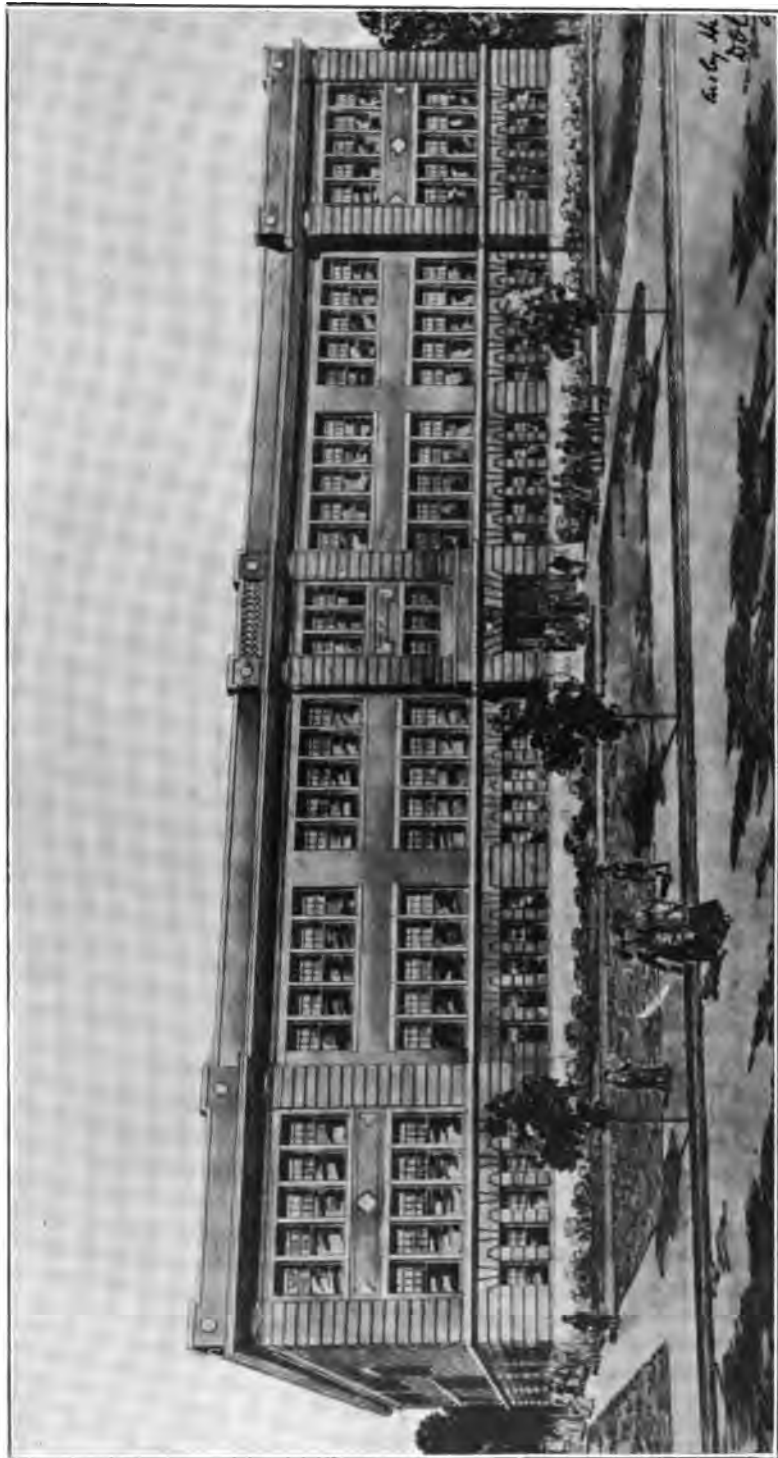


EDMUNDS HIGH SCHOOL. SECOND-FLOOR PLAN.

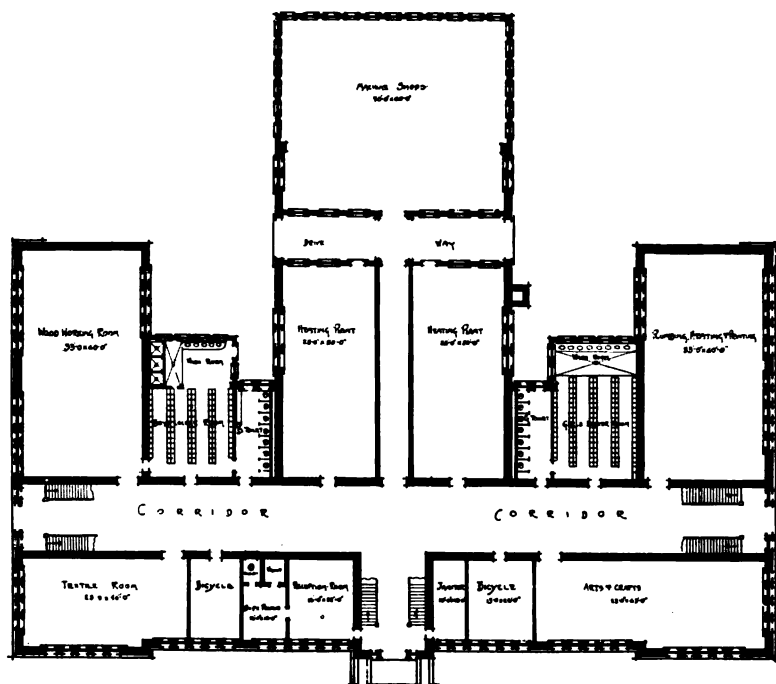


EDMUNDS HIGH SCHOOL THIRD-FLOOR PLAN.

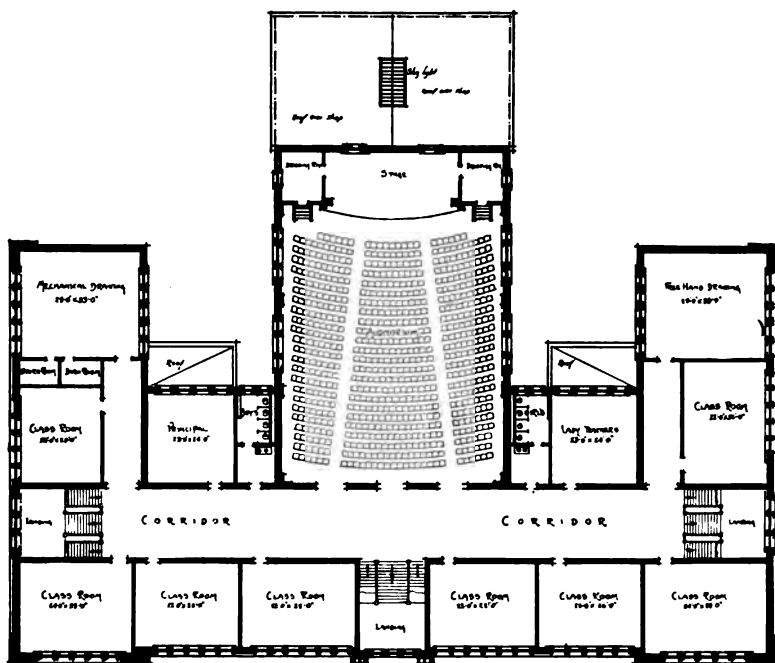




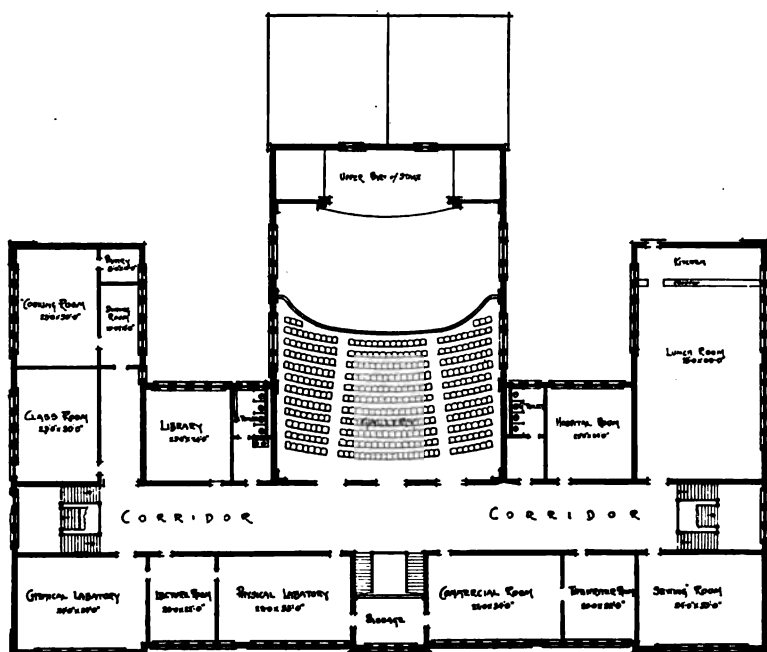
ENSLEY HIGH SCHOOL, BIRMINGHAM, ALA. D. O. WHILLDIN, ARCHITECT.



A. ENSLEY HIGH SCHOOL, BIRMINGHAM. FIRST-FLOOR PLAN.



B. ENSLEY HIGH SCHOOL, BIRMINGHAM. SECOND-FLOOR PLAN.



A. ENSLEY HIGH SCHOOL, BIRMINGHAM. THIRD-FLOOR PLAN.



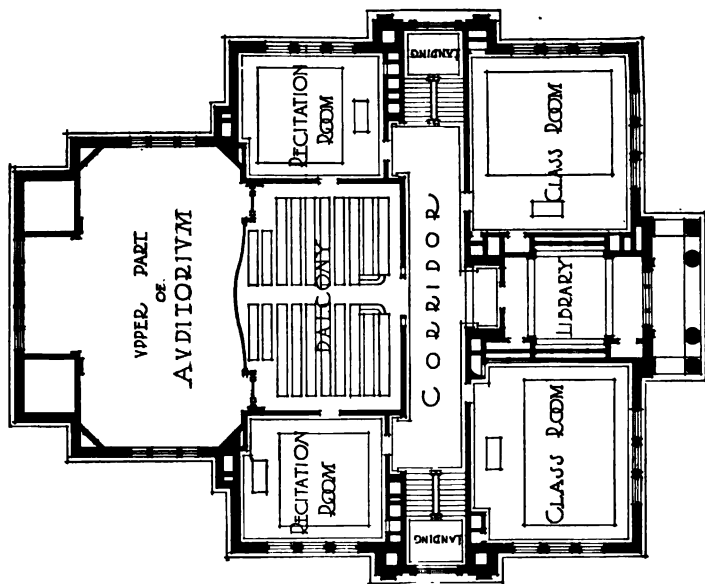
B. DALLAS COUNTY HIGH SCHOOL, PLANTERSVILLE, ALA.



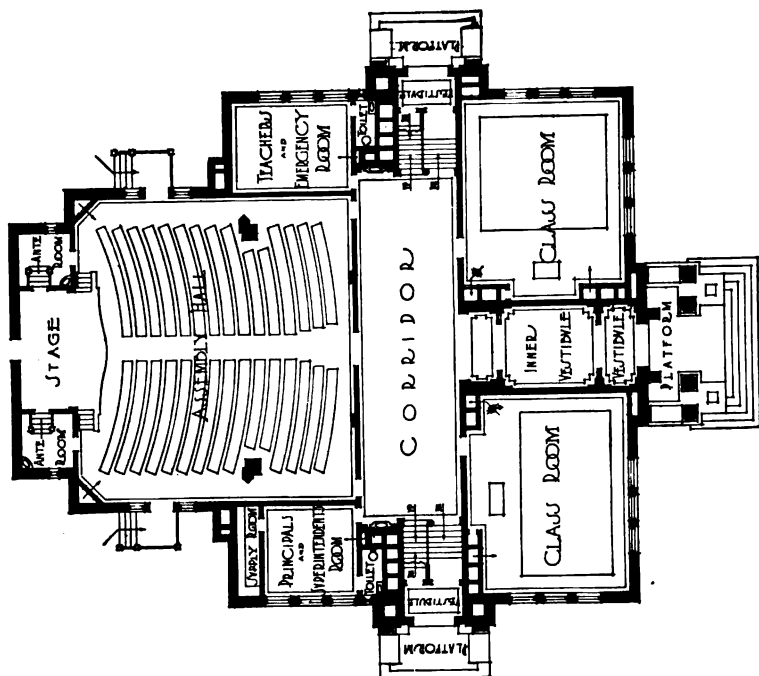
A. MASON CITY (IOWA) HIGH SCHOOL.



B. THEODORA COLT MEMORIAL HIGH SCHOOL, BRISTOL, R. I. COOPER AND  
BAILEY, ARCHITECTS.



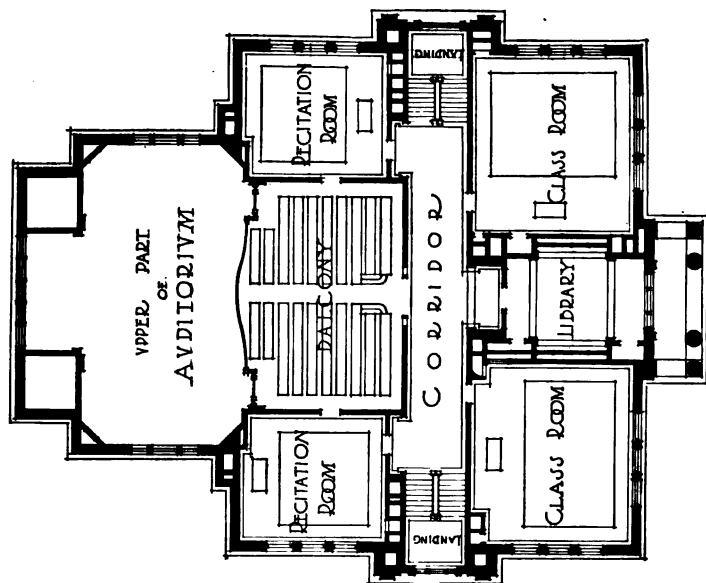
A. THEODORA COLT MEMORIAL HIGH SCHOOL,  
BRISTOL, R. I. FIRST-FLOOR PLAN.



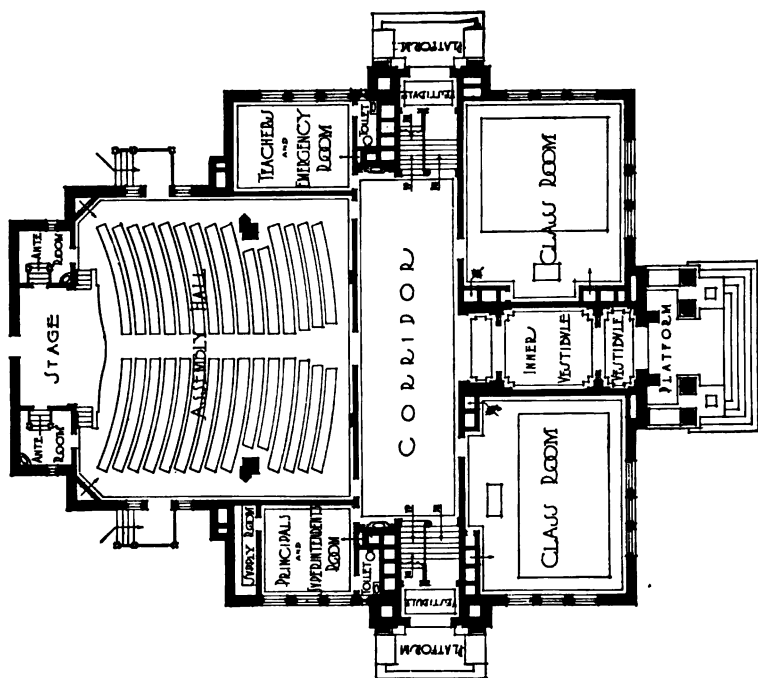
B. THEODORA COLT MEMORIAL HIGH SCHOOL, BRISTOL, R. I.  
SECOND-FLOOR PLAN.



LEBANON (N. H.) HIGH SCHOOL. COST \$25,000; NORMAL CAPACITY, 75 PUPILS.



A. THEODORA COLT MEMORIAL HIGH SCHOOL,  
BRISTOL, R.I. FIRST-FLOOR PLAN.

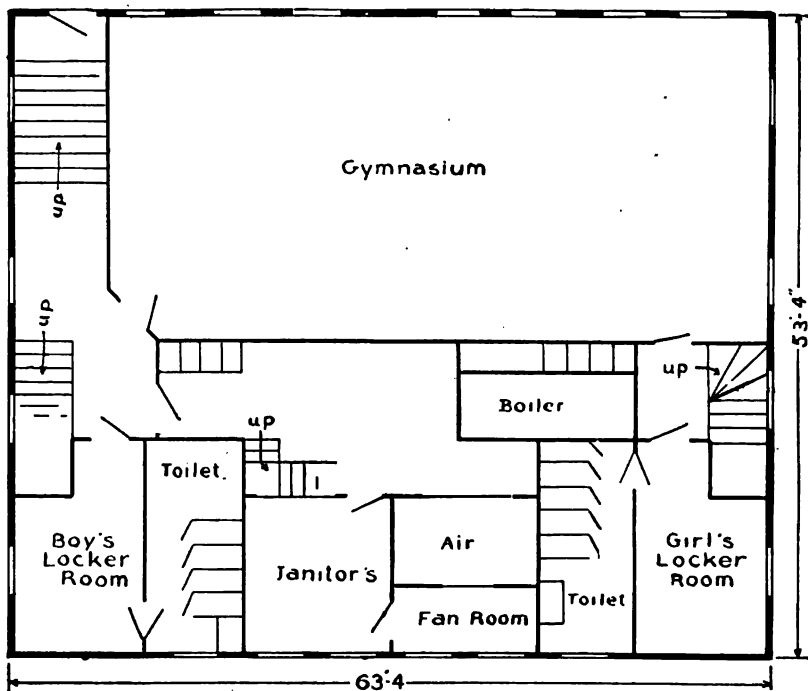


B. THEODORA COLT MEMORIAL HIGH SCHOOL, BRISTOL, R. I.  
SECOND-FLOOR PLAN.

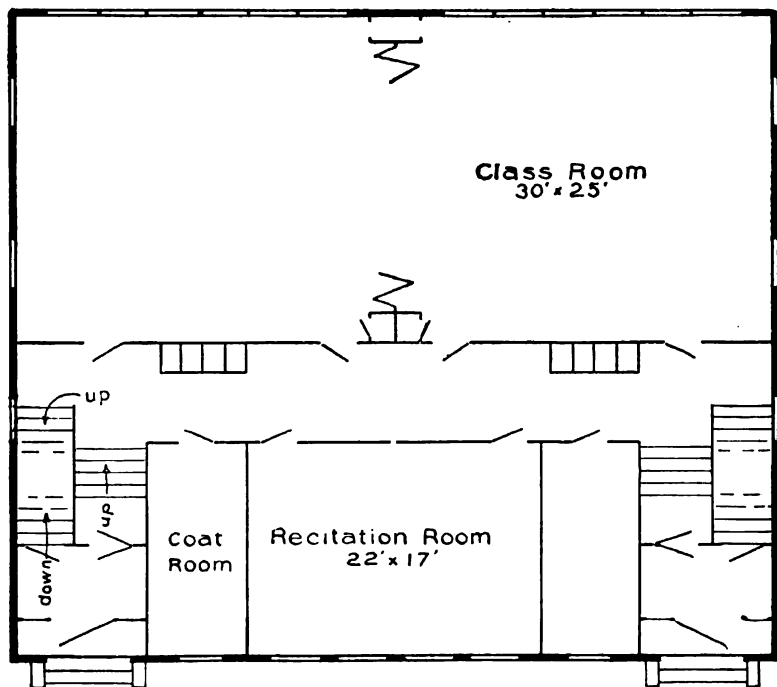


LEBANON (N. H.) HIGH SCHOOL. COST \$25,000; NORMAL CAPACITY, 75 PUPILS.

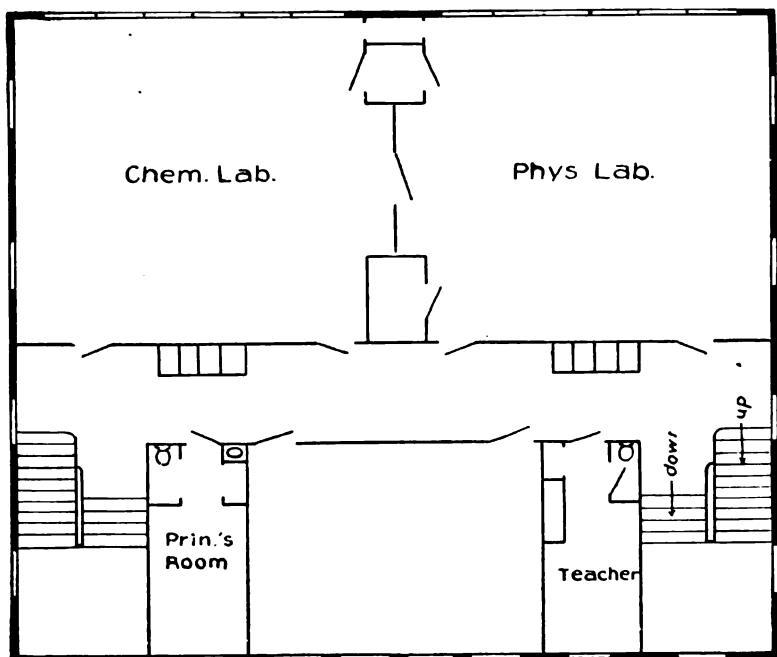




A. LEBANON HIGH SCHOOL. BASEMENT PLAN.



B. LEBANON HIGH SCHOOL. FIRST-FLOOR PLAN.



A. LEBANON HIGH SCHOOL. SECOND-FLOOR PLAN.



B. SAN DIEGO (CAL.) HIGH SCHOOL. F. C. ALLEN, ARCHITECT.



A. DOUGLAS (ARIZ.) HIGH SCHOOL. J. A. HOLDEN, ARCHITECT.



B. DOUGLAS HIGH SCHOOL. COURT.



A. EVELETH (MINN.) HIGH SCHOOL. A GOOD TYPE.



B. DAWSON (MINN.) HIGH SCHOOL.



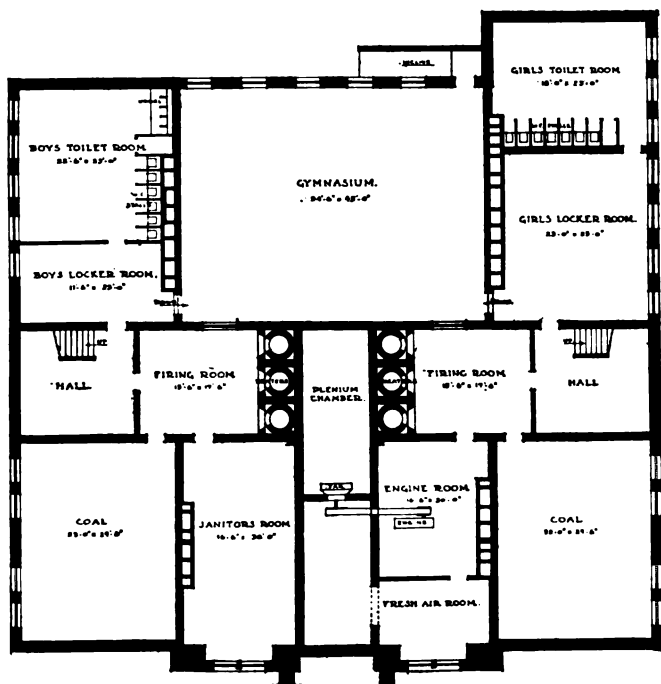
A. WINNSBORO (LA.) HIGH SCHOOL.

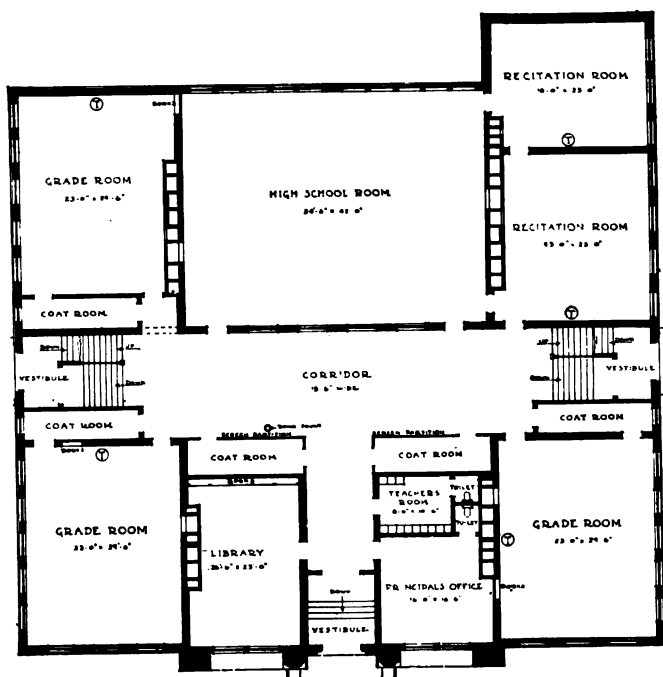


B. TERREBONNE HIGH SCHOOL, HOUMA, LA.

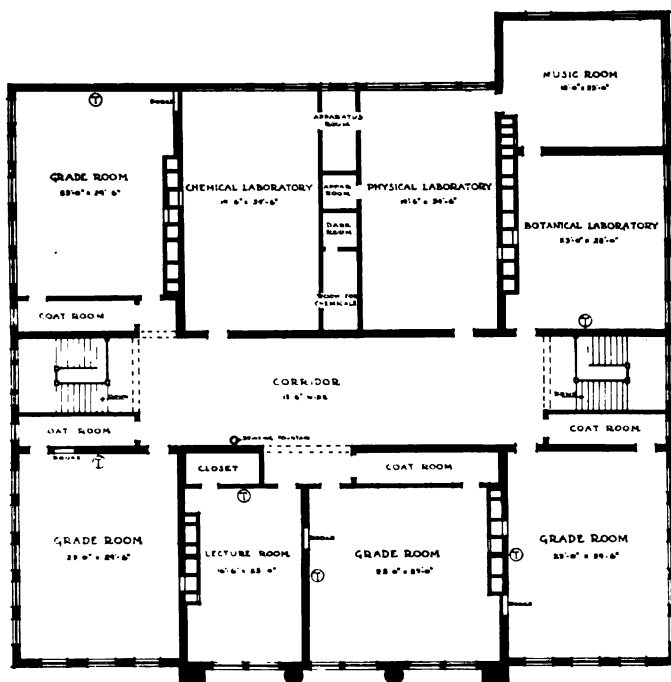


**B. WEEDSPORT PUBLIC SCHOOL. BASEMENT PLAN**

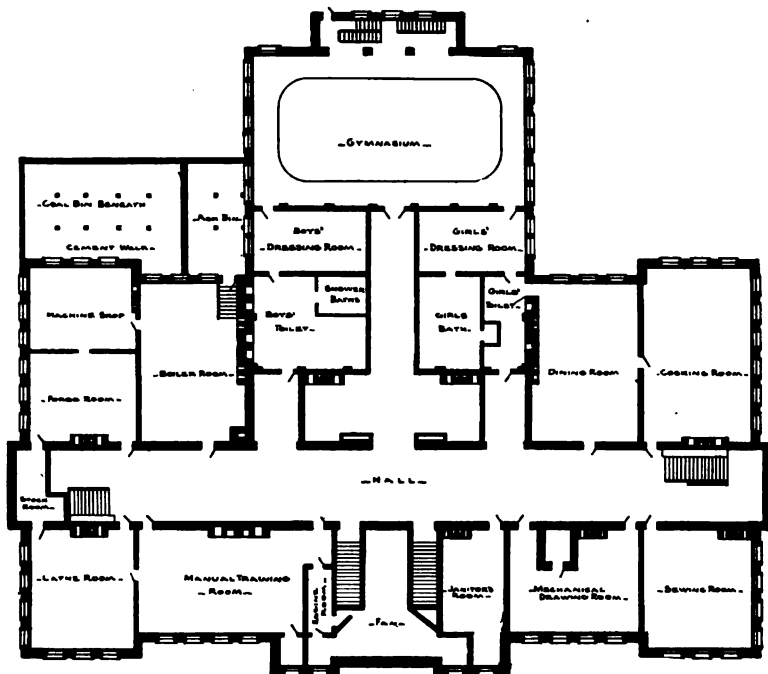




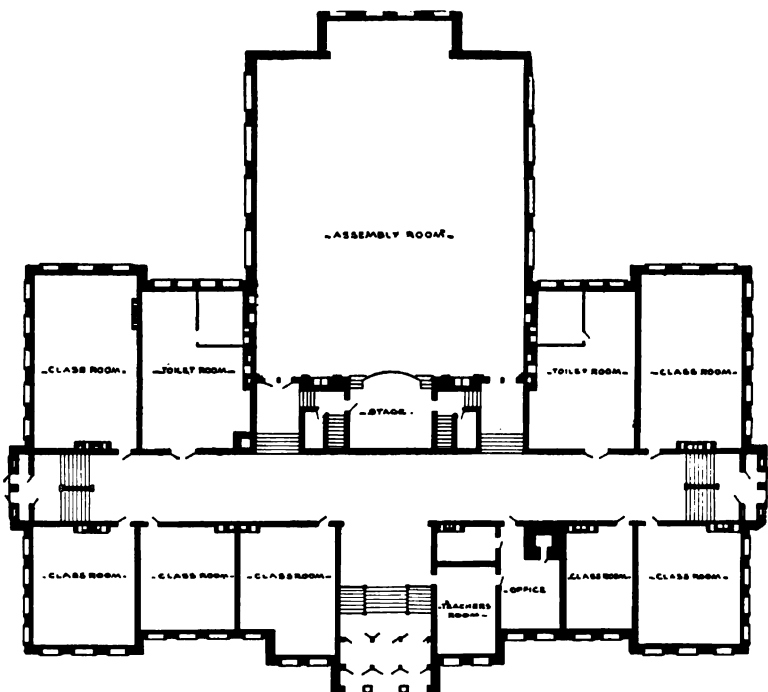
4. WEEDSPORT PUBLIC SCHOOL. FIRST-FLOOR PLAN.



5. WEEDSPORT PUBLIC SCHOOL. SECOND-FLOOR PLAN.

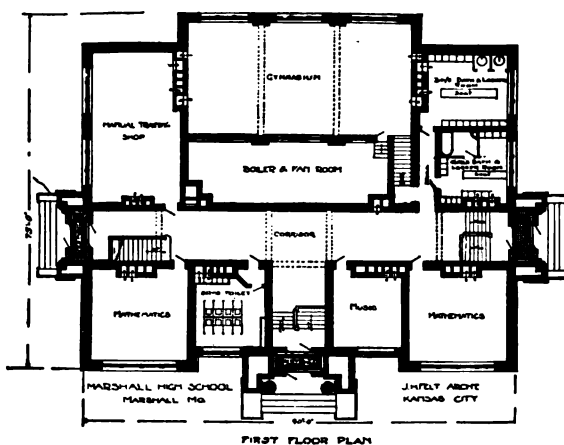


A. APPLETON (WIS.) HIGH SCHOOL. BASEMENT PLAN.

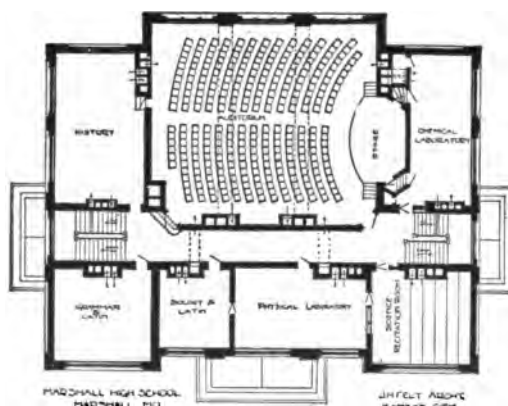


B. APPLETON (WIS.) HIGH SCHOOL. FIRST-FLOOR PLAN.



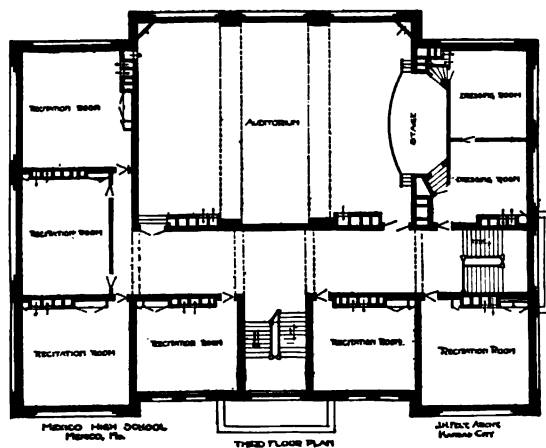
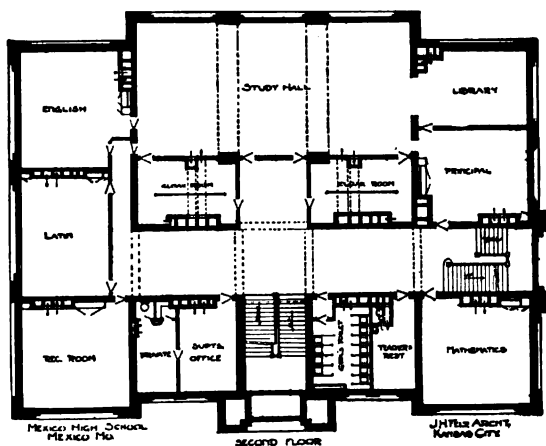
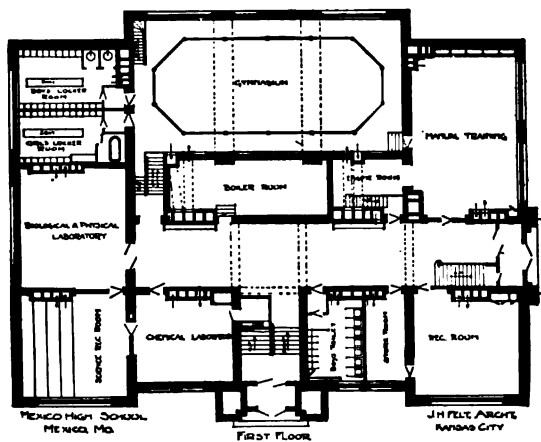


SECOND FLOOR PLAN

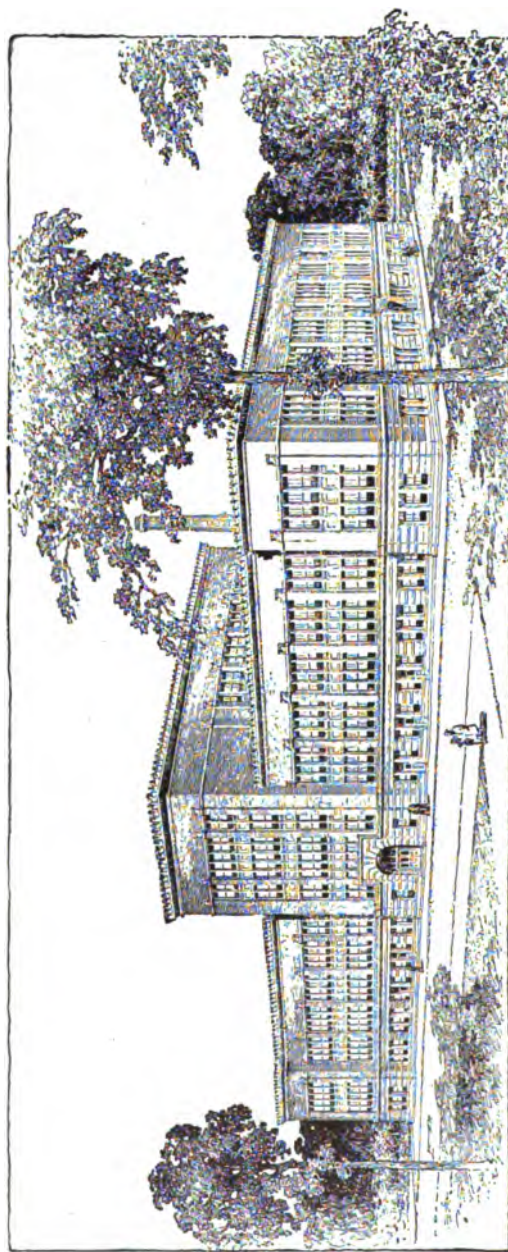


THIRD FLOOR PLAN

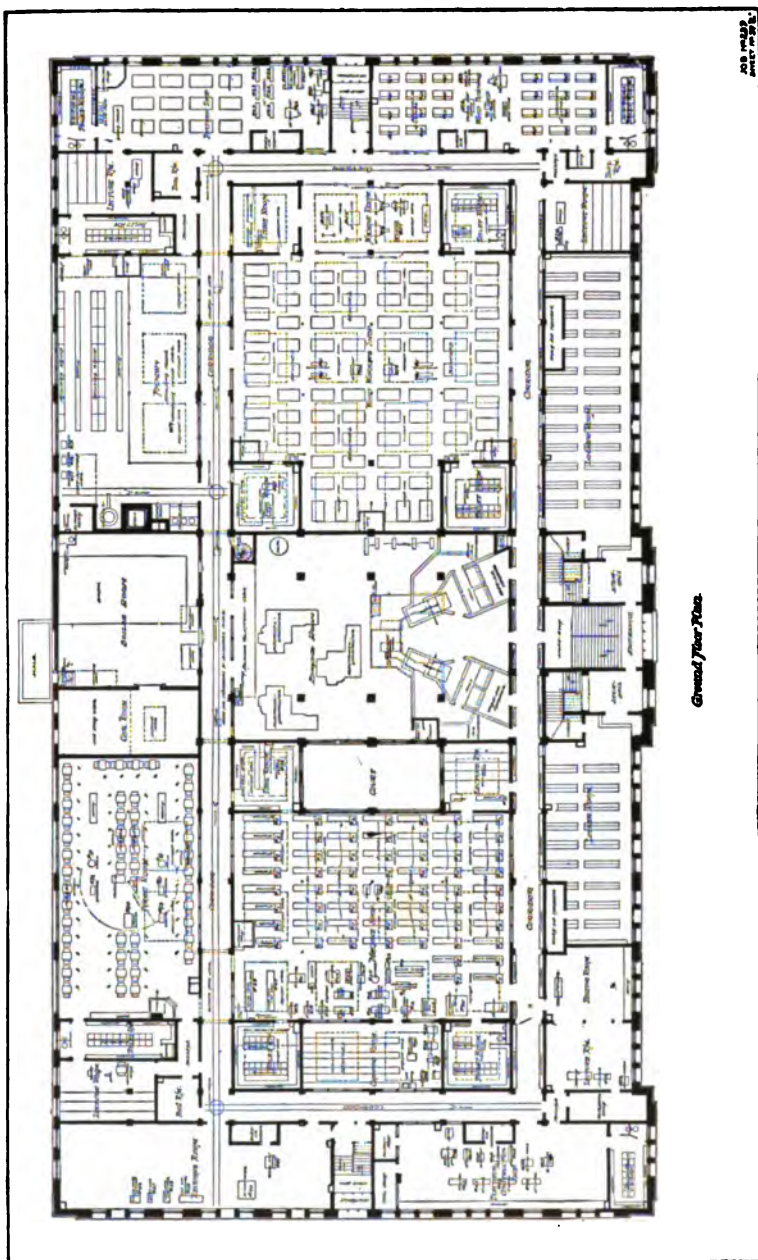
A, B, C. MARSHALL (MO.) HIGH SCHOOL. FLOOR PLANS.



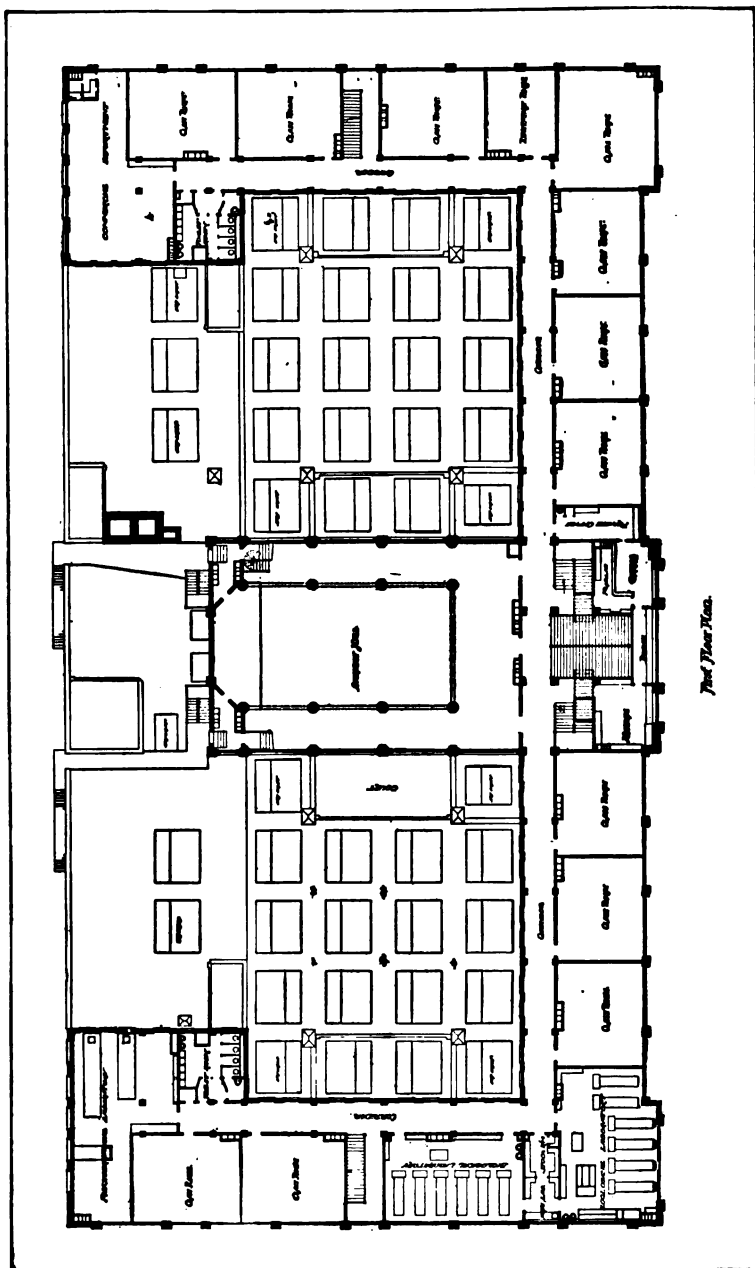
A, B, C. MEXICO (MO.) HIGH SCHOOL. FLOOR PLANS.

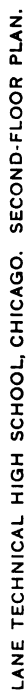


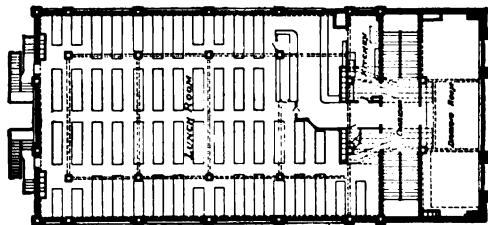
ALBERT G. LANE TECHNICAL HIGH SCHOOL, CHICAGO, ILL.



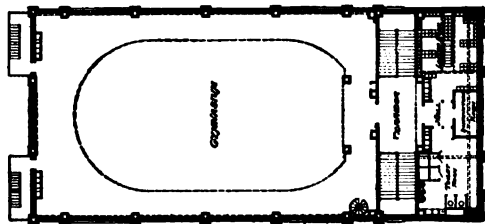
LANE TECHNICAL HIGH SCHOOL, CHICAGO. GROUND-FLOOR PLAN.



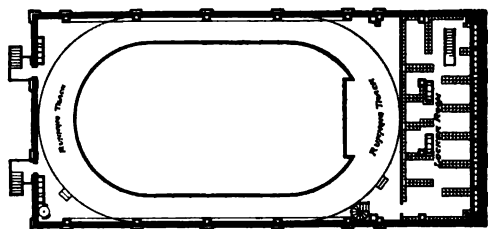




*Third Floor Plan*



*Fourth Floor Plan*



*Running Track Floor Plan*

LANE TECHNICAL HIGH SCHOOL, CHICAGO. PLANS OF UPPER FLOORS.



A. TECHNICAL HIGH SCHOOL, CLEVELAND, OHIO.

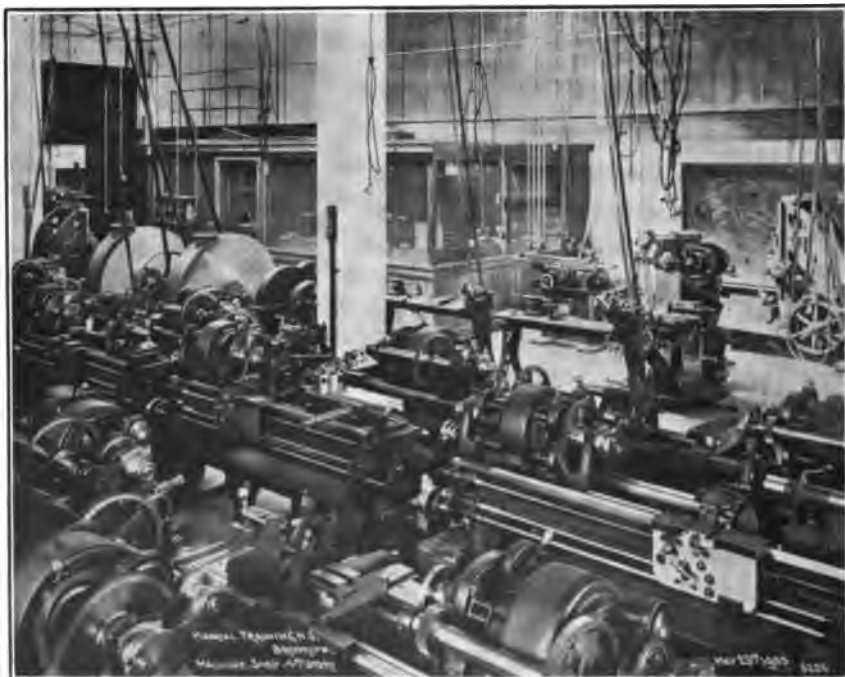


B. FORGE SHOP, STUYVESANT HIGH SCHOOL, NEW YORK CITY.





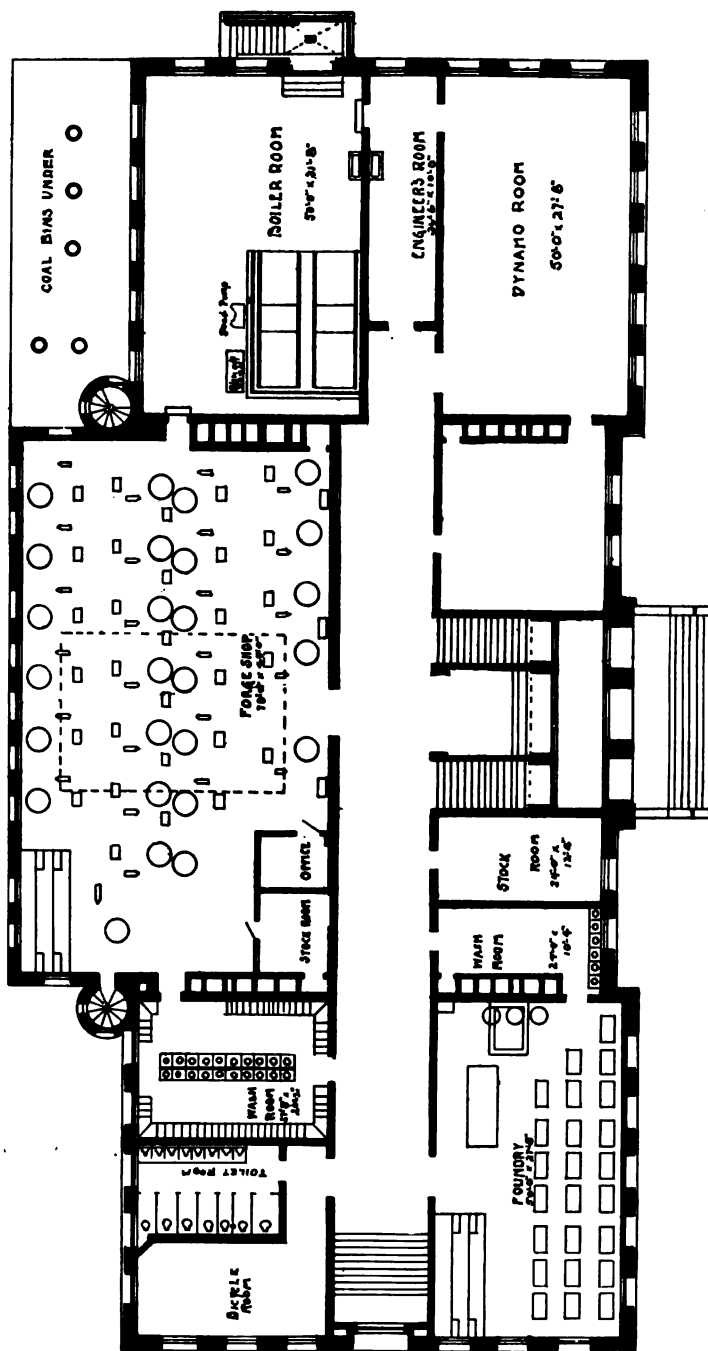
A. WOOD SHOP, MANUAL TRAINING HIGH SCHOOL, BOROUGH OF BROOKLYN, NEW YORK CITY.



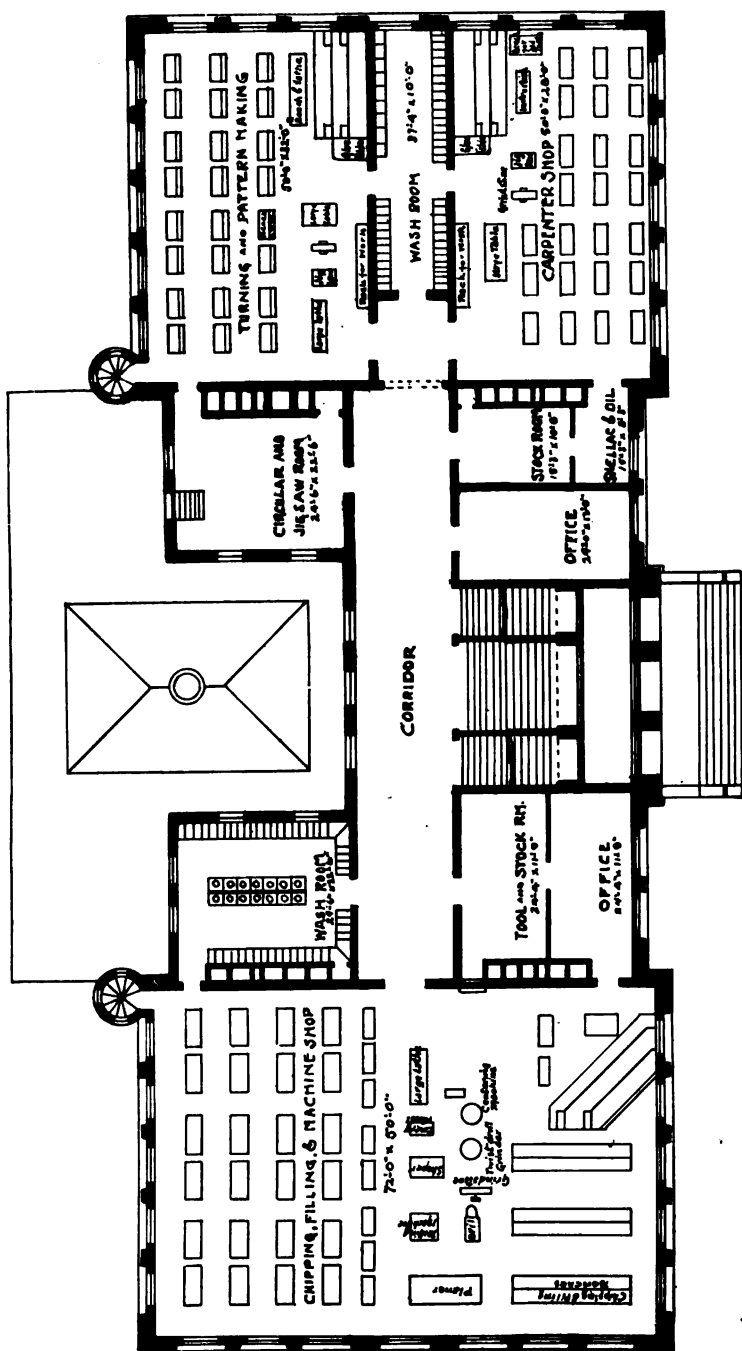
B. MACHINE SHOP, MANUAL TRAINING HIGH SCHOOL, BOROUGH OF BROOKLYN, NEW YORK CITY.



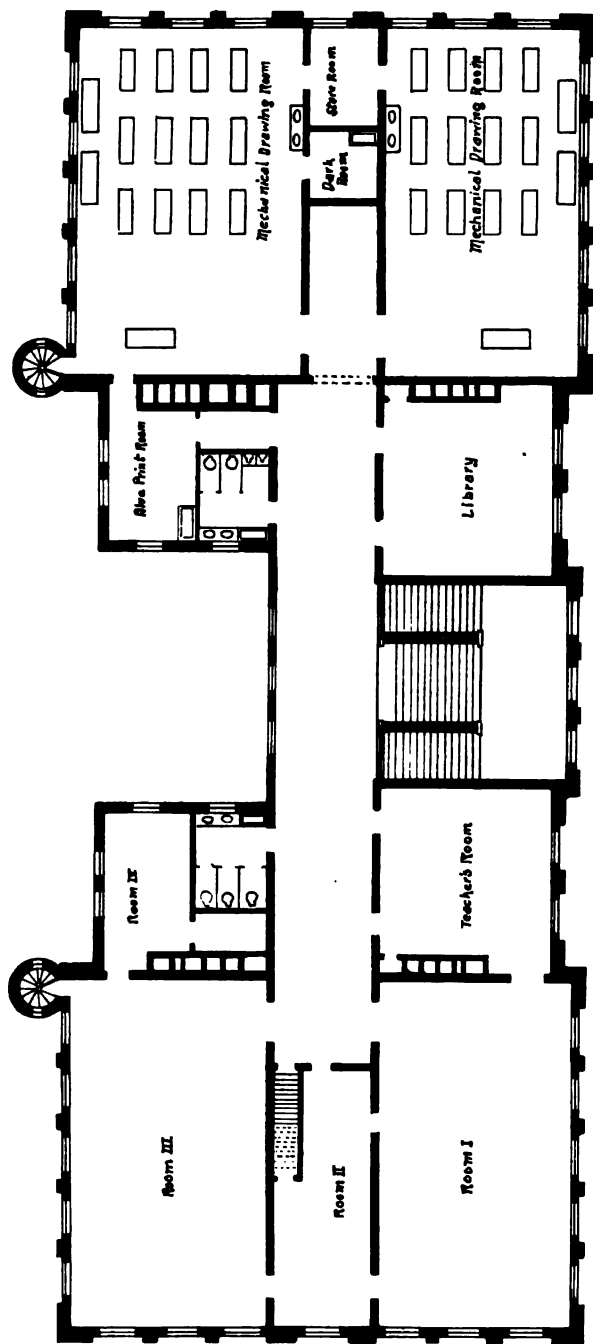
MANUAL TRAINING BUILDING, HIGH SCHOOL, BROOKLINE, MASS.



MANUAL TRAINING BUILDING, HIGH SCHOOL, BROOKLINE. BASEMENT PLAN.



MANUAL TRAINING BUILDING, HIGH SCHOOL, BROOKLINE. FIRST-FLOOR PLAN.



MANUAL TRAINING BUILDING, HIGH SCHOOL, BROOKLINE. SECOND-FLOOR PLAN.



MANUAL TRAINING BUILDING, HIGH SCHOOL, BROOKLINE. WOOD-TURNING LABORATORY.



MANUAL TRAINING BUILDING, HIGH SCHOOL, BROOKLINE. MACHINE-TOOL LABORATORY.

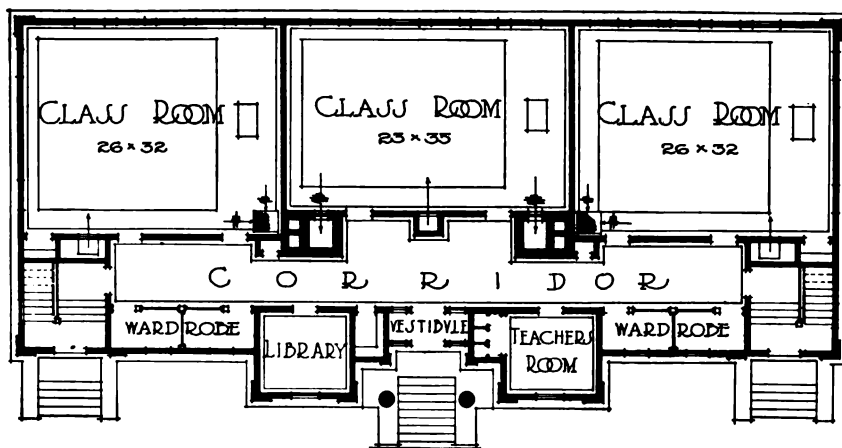


MANUAL TRAINING BUILDING, HIGH SCHOOL, BROOKLINE. NEEDLEWORK ROOM.





A. AMES SCHOOL, SOUTH EASTON, MASS. COOPER & BAILEY, ARCHITECTS.



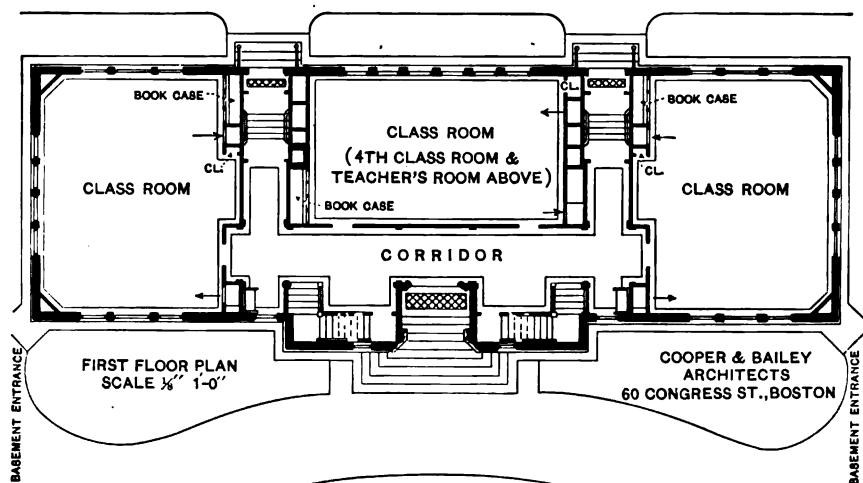
B. AMES SCHOOL, SOUTH EASTON. FLOOR PLAN.



A. DOLLY WHITNEY ADAMS SCHOOL, ASHBURNHAM, MASS. COOPER & BAILEY, ARCHITECTS. SOUTH FRONT.



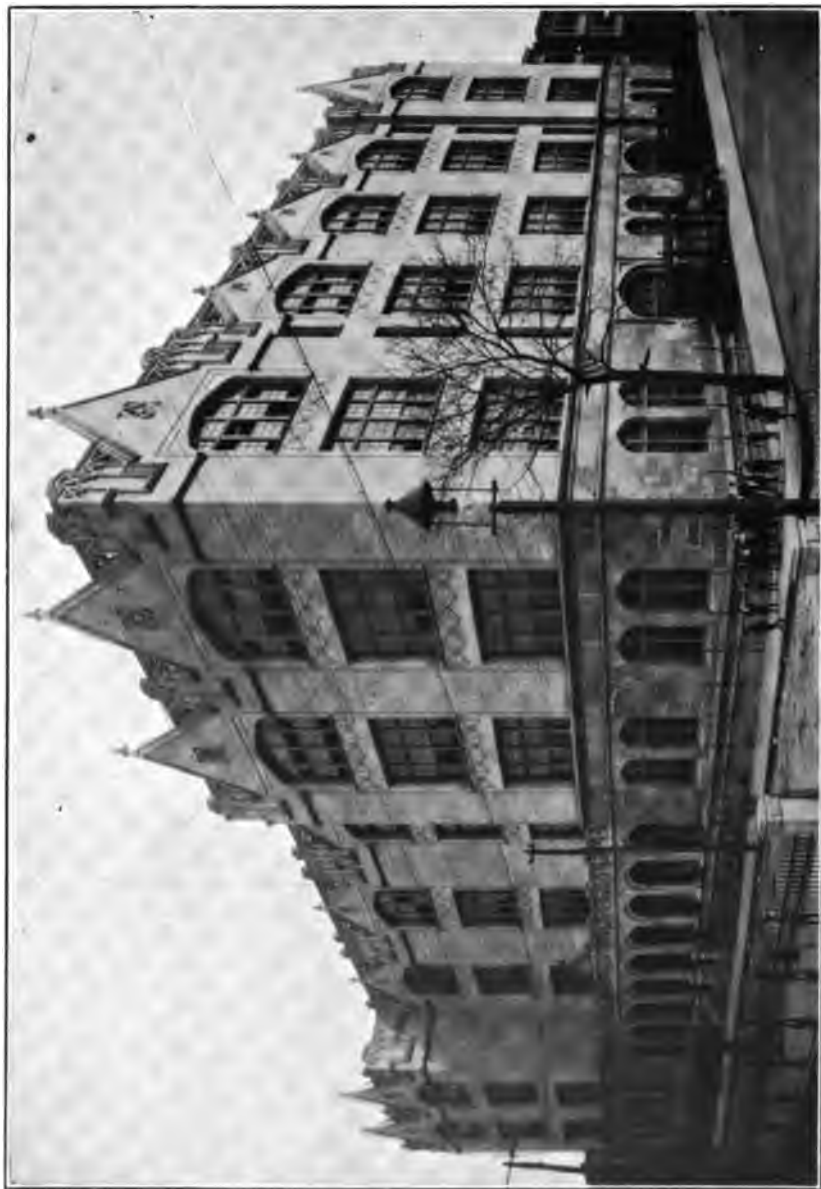
B. DOLLY WHITNEY ADAMS SCHOOL. NORTH FRONT.



A. DOLLY WHITNEY ADAMS SCHOOL, ASHBURNHAM. FLOOR PLAN.



B. PUBLIC SCHOOL NO. 33, BOROUGH OF RICHMOND, NEW YORK CITY.  
C. B. J. SNYDER, ARCHITECT.



PUBLIC SCHOOL NO. 5, BOROUGH OF BROOKLYN, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT.



PUBLIC SCHOOL NO. 165, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT. THIS TOWER IS NOT IMPERTINENT.



TEACHERS' TRAINING SCHOOL, BOROUGH OF BROOKLYN, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT.



PUBLIC SCHOOL NO. 62, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT.



PUBLIC SCHOOL NO. 154, BOROUGH OF THE BRONX, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT.

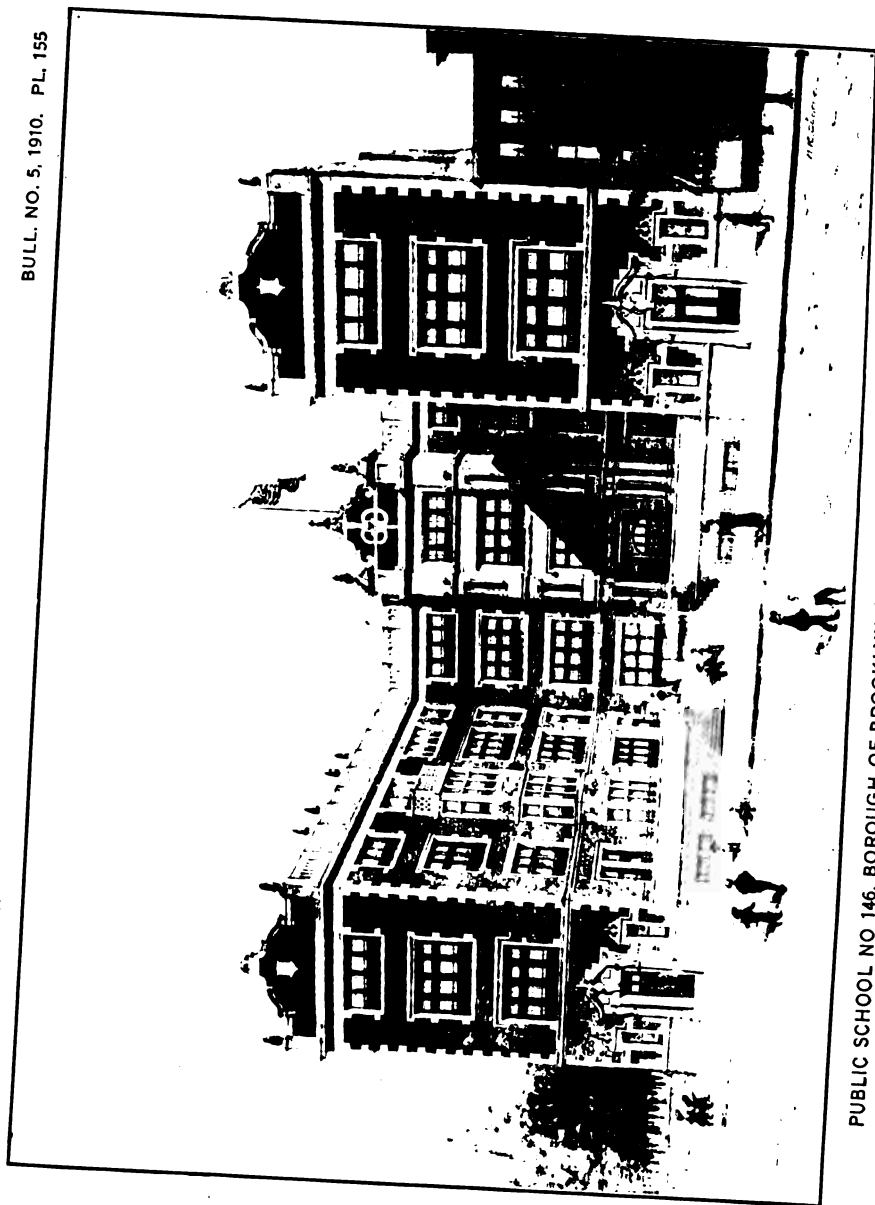




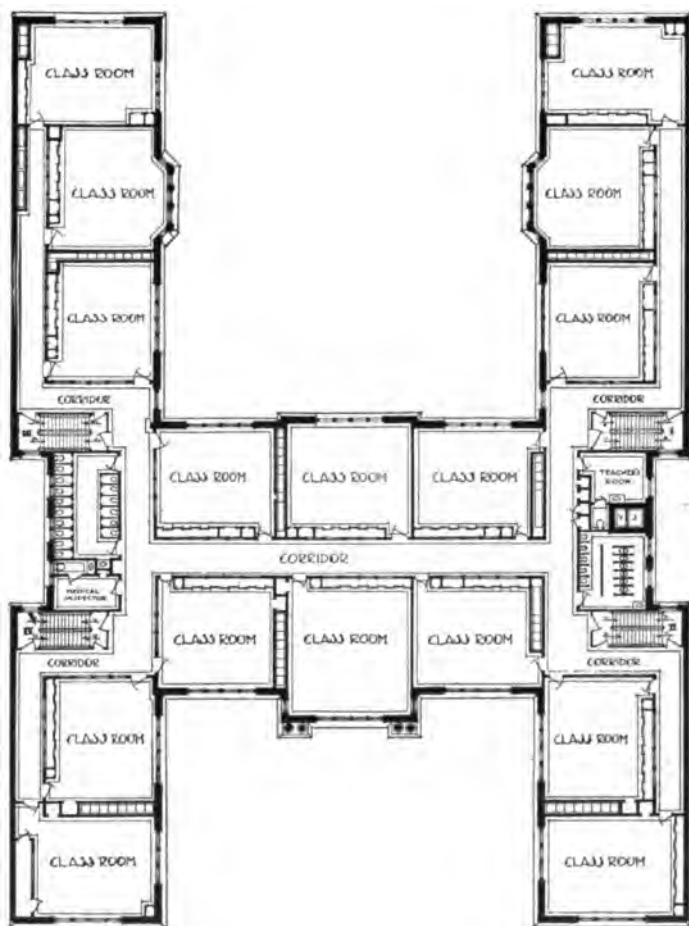
PUBLIC SCHOOL NO. 147, BOROUGH OF BROOKLYN, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT.



PUBLIC SCHOOL NO. 37, BOROUGH OF THE BRONX, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT. (SEE PAGE 125.)



PUBLIC SCHOOL NO 146, BOROUGH OF BROOKLYN, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT.  
TYPICAL "H" PLAN.



PUBLIC SCHOOL NO. 146, BROOKLYN. SECOND, OR TYPICAL, FLOOR PLAN.





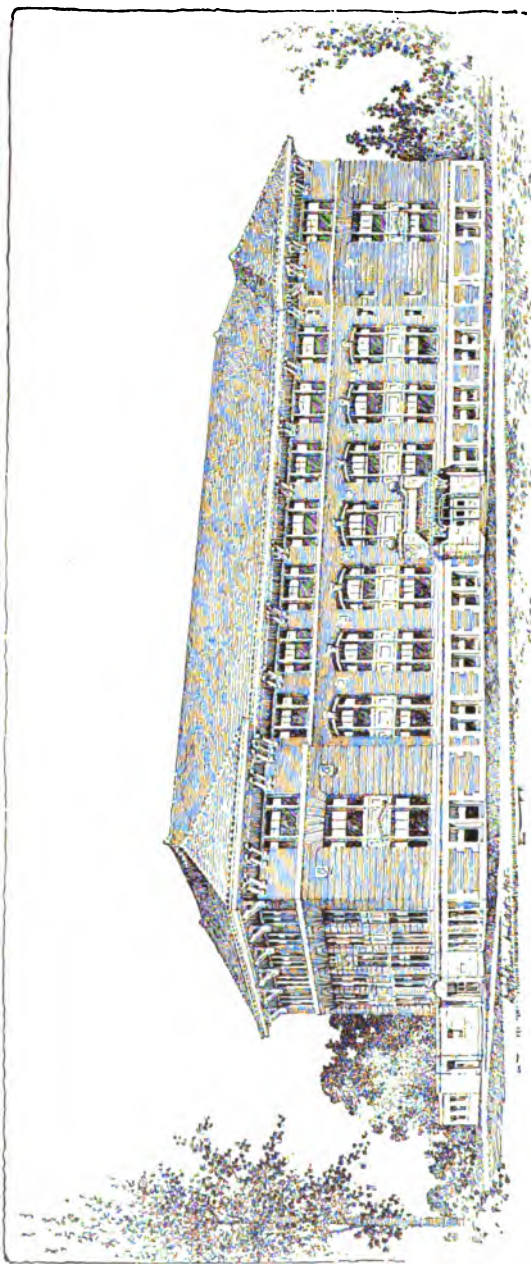
PUBLIC SCHOOL NO. 21, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT.



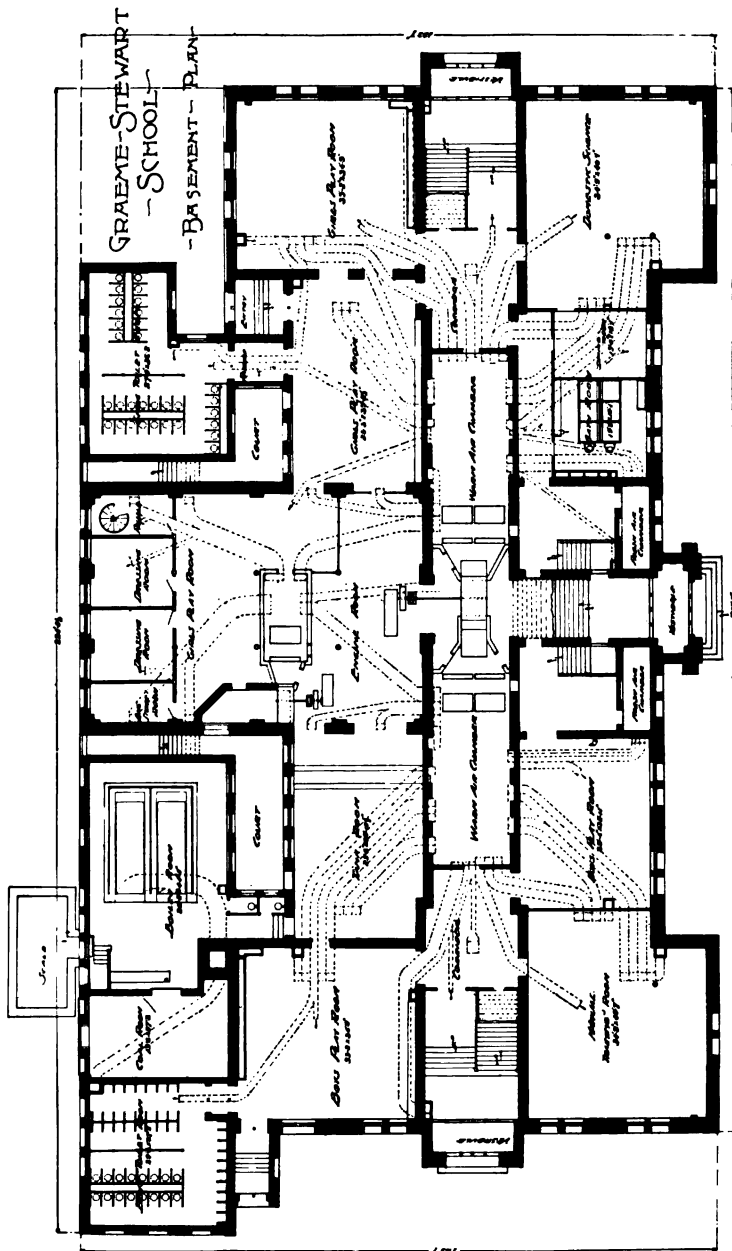
**A. PUBLIC SCHOOL NO. 153, BOROUGH OF THE BRONX, NEW YORK CITY.  
C. B. J. SNYDER, ARCHITECT.**



**B. PUBLIC SCHOOL NO. 34, BOROUGH OF RICHMOND, NEW YORK CITY.  
C. B. J. SNYDER, ARCHITECT.**



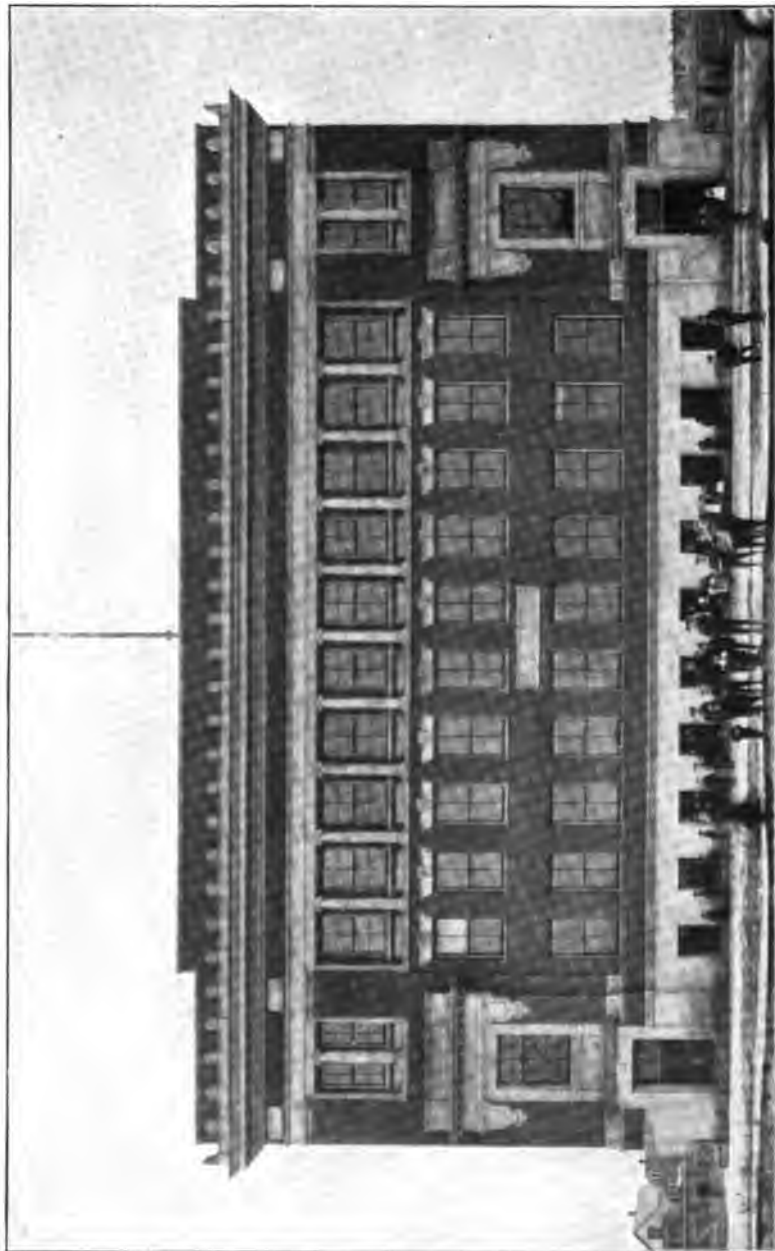
GRAEME STEWART SCHOOL, CHICAGO, ILL. D. H. PERKINS, ARCHITECT.



GRAEME STEWART SCHOOL, CHICAGO. BASEMENT PLAN.



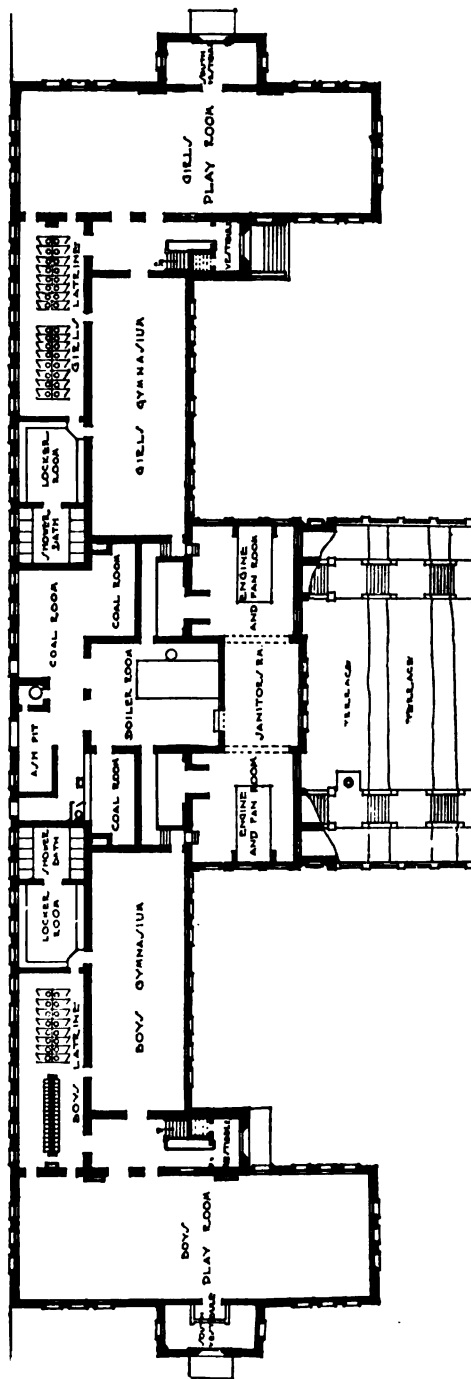




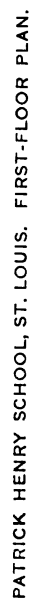
HERBERT SPENCER SCHOOL, CHICAGO, ILL. ONE-HALF OF A 24-ROOM BUILDING.

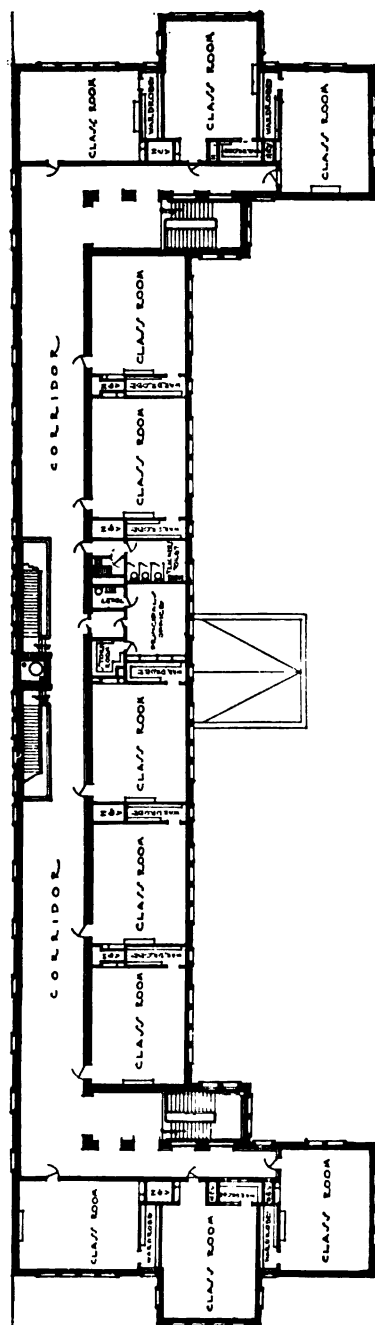


PATRICK HENRY SCHOOL, ST. LOUIS, MO. WM. B. ITTNER, ARCHITECT.

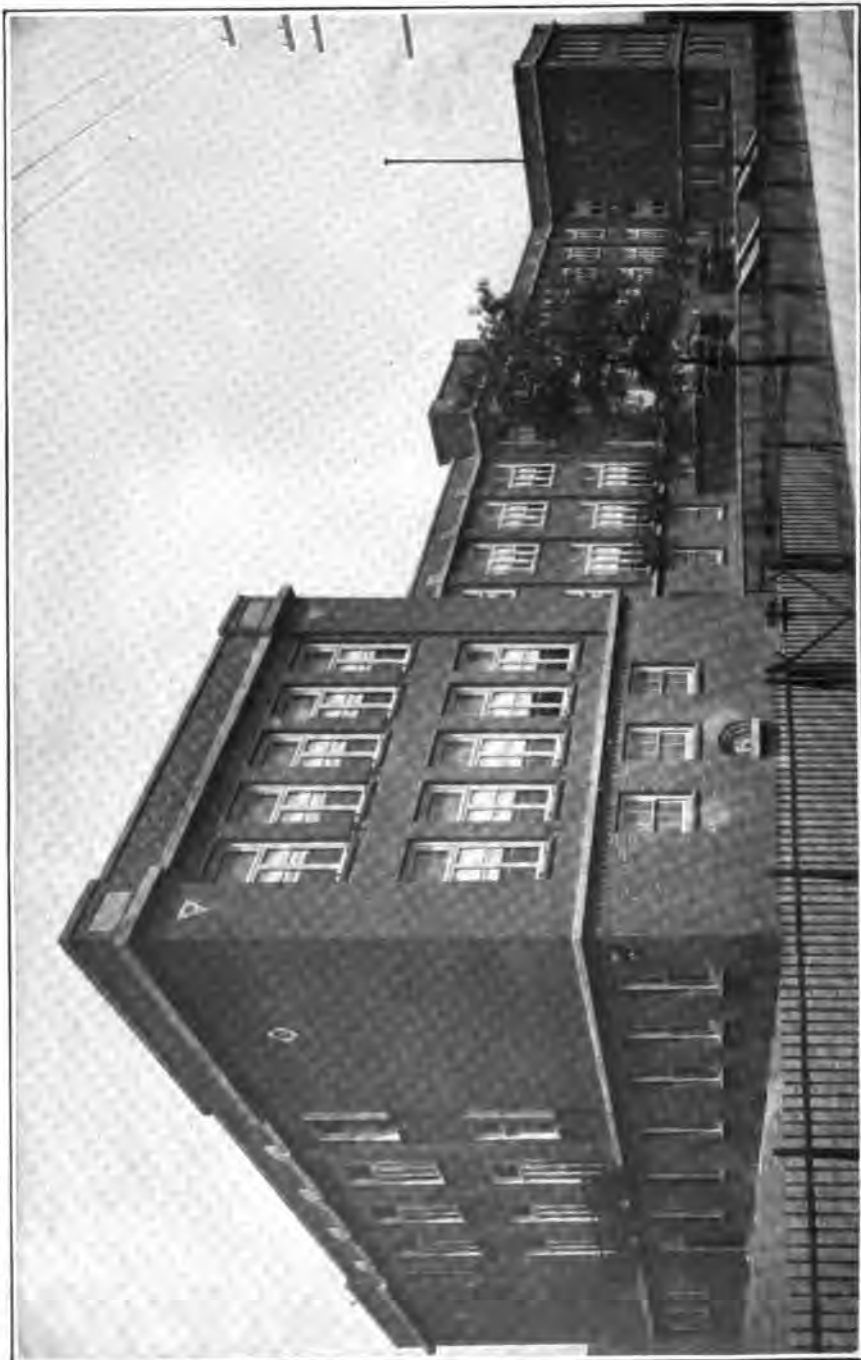


PATRICK HENRY SCHOOL, ST. LOUIS. BASEMENT PLAN.



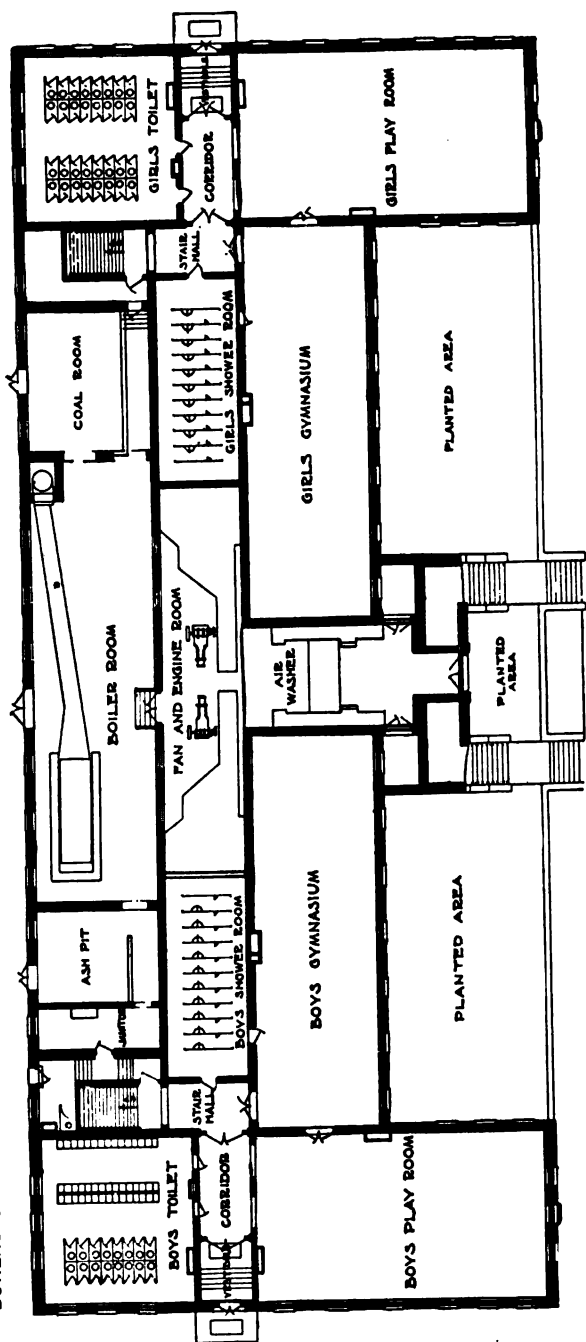


PATRICK HENRY SCHOOL, ST. LOUIS. SECOND-FLOOR PLAN.



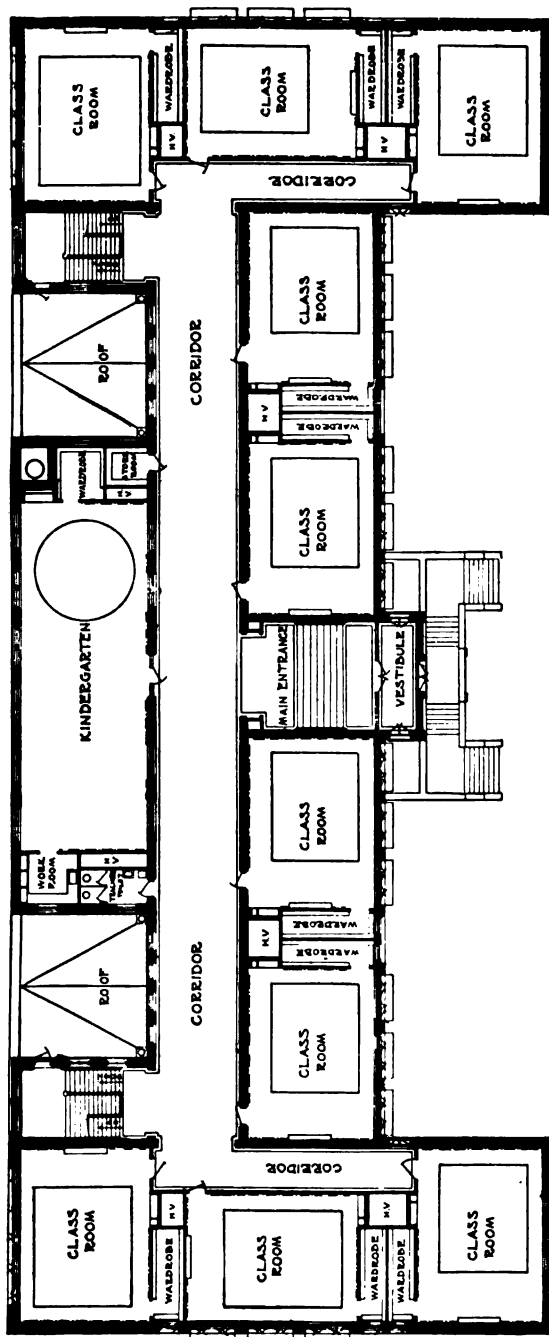
LAFAYETTE SCHOOL, ST. LOUIS, MO. WM. B. ITTNER, ARCHITECT. THE HALF "H" PLAN.

BUREAU OF EDUCATION

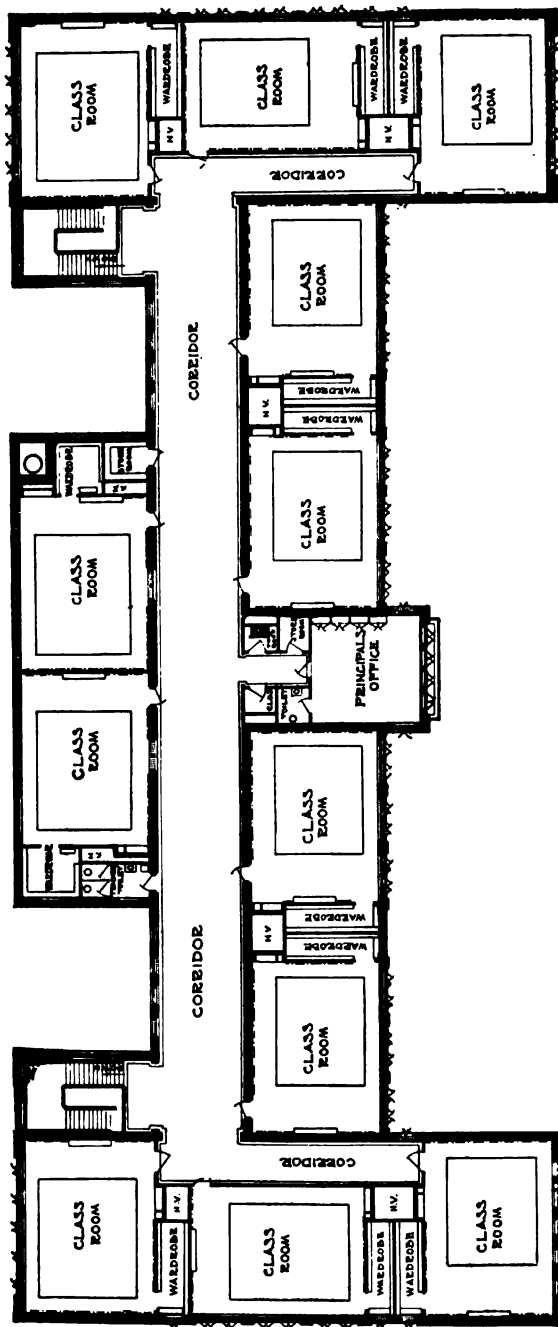


LAFAYETTE SCHOOL, ST. LOUIS. BASEMENT PLAN.





LAFAYETTE SCHOOL, ST. LOUIS. FIRST-FLOOR PLAN.

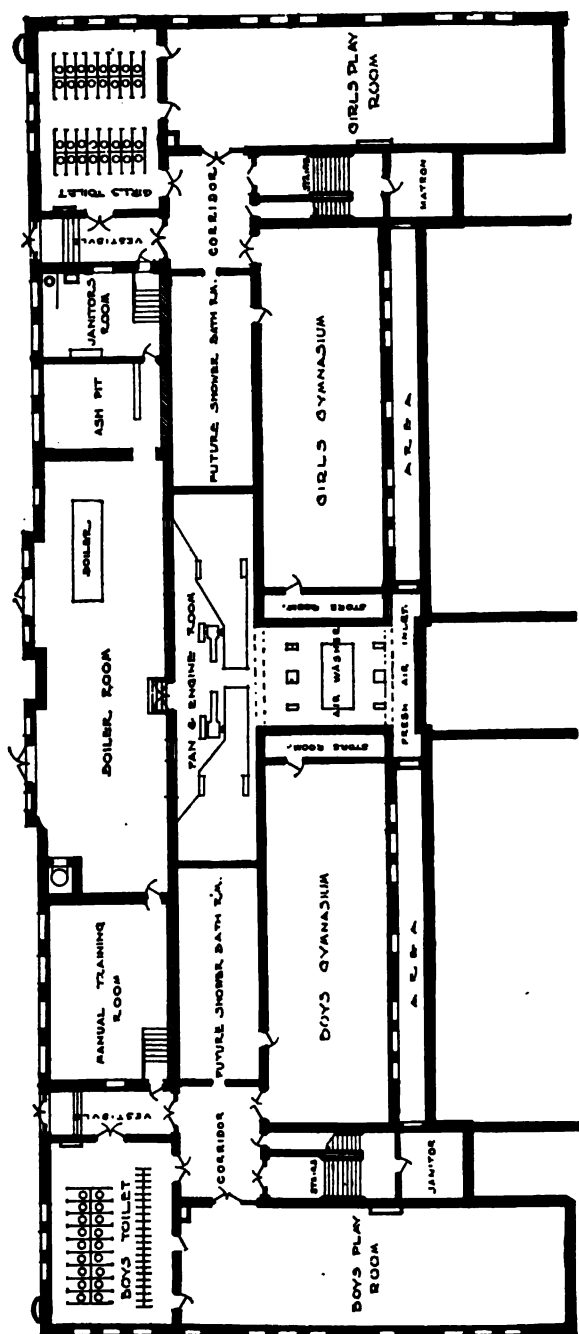


LAFAYETTE SCHOOL, ST. LOUIS. SECOND-FLOOR PLAN.

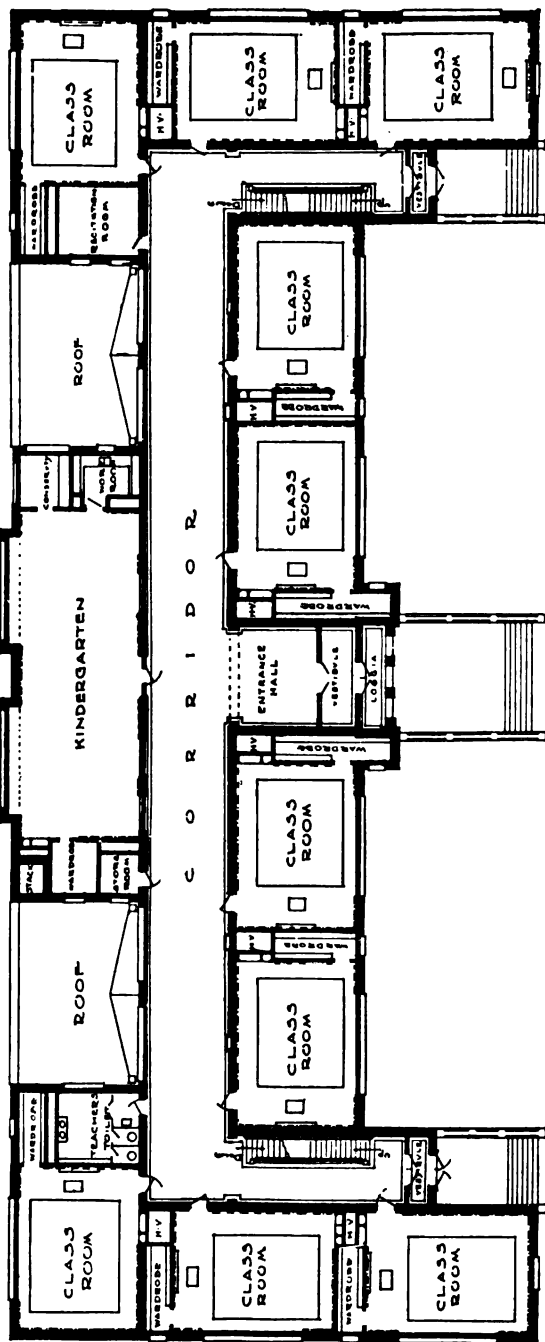


WILLIAM CLARK SCHOOL, ST. LOUIS, MO. WM. B. ITTNER, ARCHITECT.

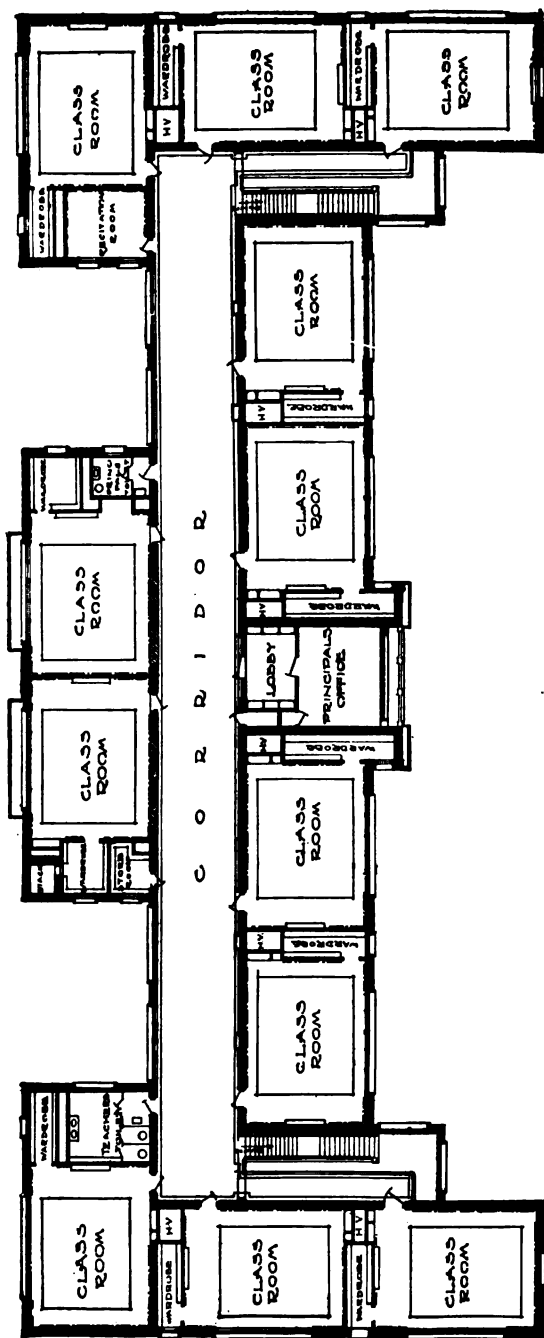
BUREAU OF EDUCATION



WILLIAM CLARK SCHOOL, ST. LOUIS. BASEMENT PLAN.



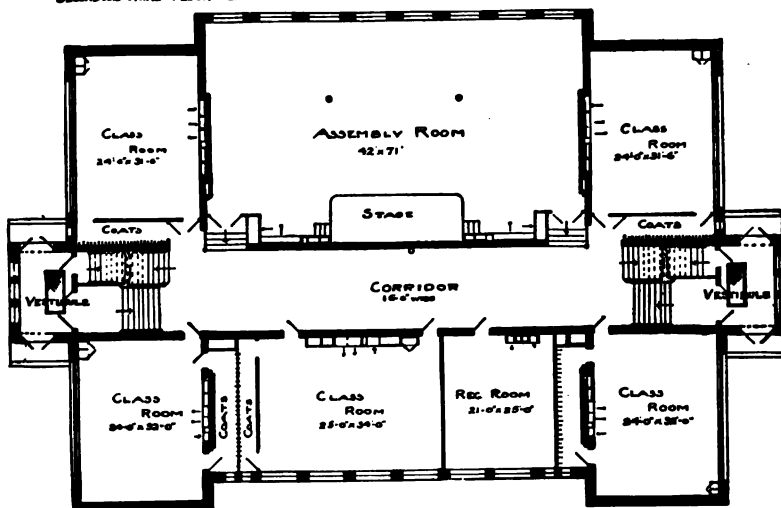
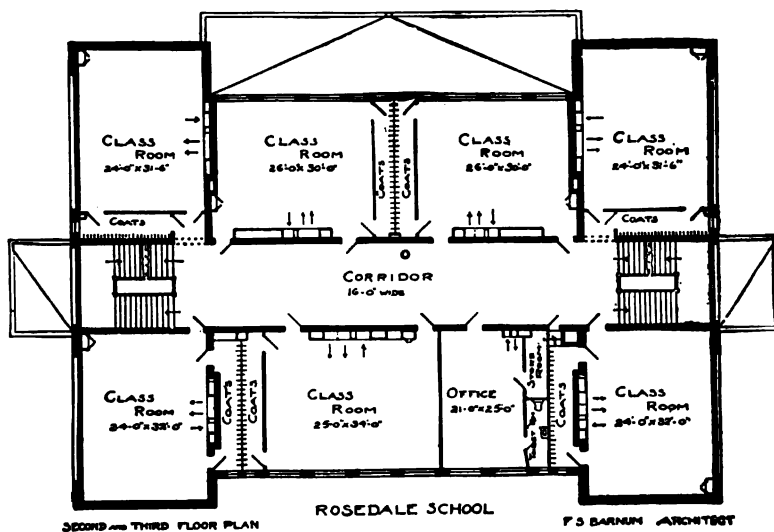
WILLIAM CLARK SCHOOL, ST. LOUIS. FIRST-FLOOR PLAN.



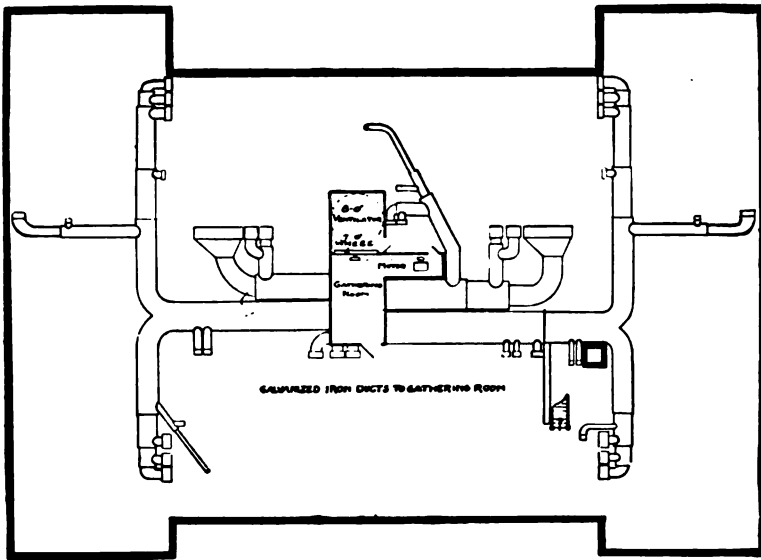
WILLIAM CLARK SCHOOL, ST. LOUIS. SECOND-FLOOR PLAN.



ROSEDALE SCHOOL, CLEVELAND, OHIO. F. S. BARNUM, ARCHITECT.







A.—ROSEDALE SCHOOL, CLEVELAND. ATTIC PLAN.



B.—ROSEDALE SCHOOL, CLEVELAND. SCHOOL GARDEN.



**A. RICE SCHOOL, CLEVELAND, OHIO. AN EXAMPLE OF BUILDING ON THE UNIT PLAN. THE RIGHT HALF OF THE BUILDING, CONTAINING EIGHT ROOMS, WAS CONSTRUCTED FIRST. (SEE PAGES 124 AND 126.)**



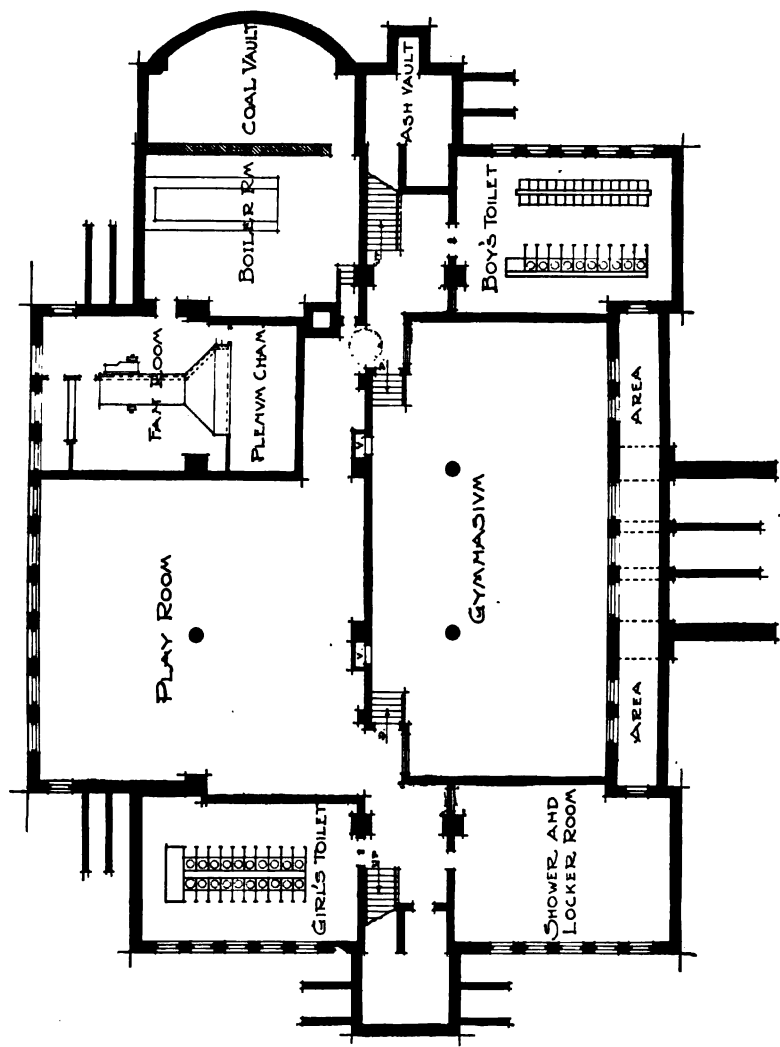
**B. HALLE SCHOOL, CLEVELAND, OHIO. SIXTEEN ROOMS AND AUDITORIUM. THIS BUILDING WAS ORIGINALLY ERECTED IN 1904 AND THEN CONTAINED EIGHT ROOMS.**



**A. MILFORD SCHOOL, CLEVELAND, OHIO. THE ORIGINAL BUILDING ON THE RIGHT CONTAINS TWELVE ROOMS. THE ANNEX ON THE LEFT ALSO CONTAINS TWELVE ROOMS.**

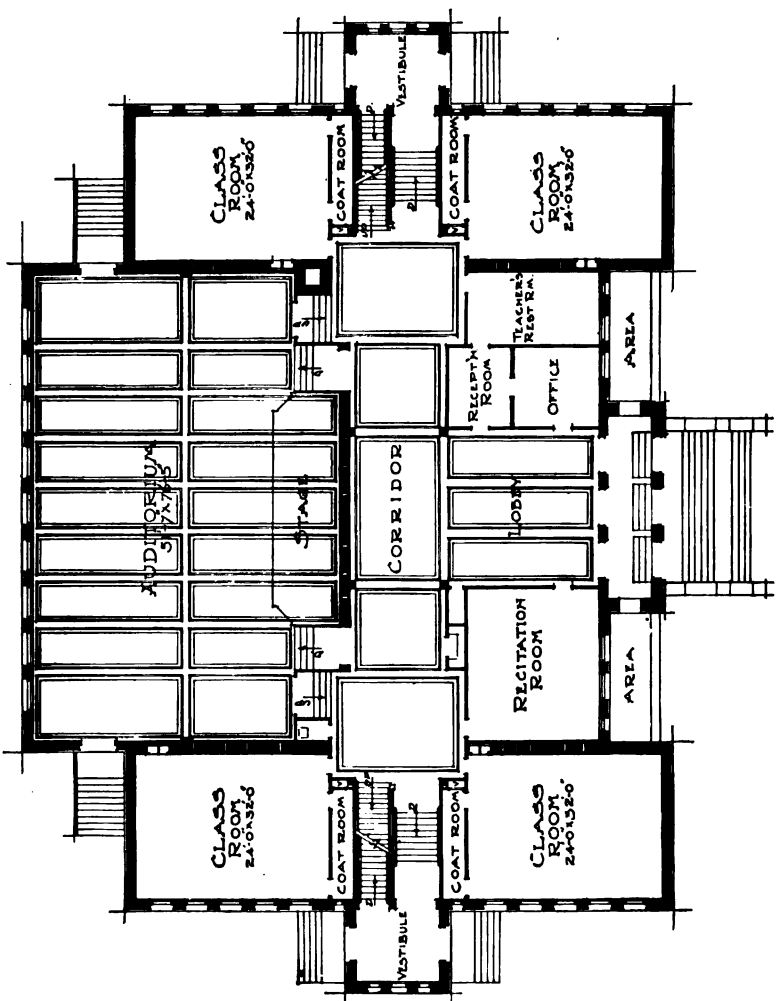


**B. COLUMBIA SCHOOL, CLEVELAND, OHIO. (SEE PAGE 124.)**



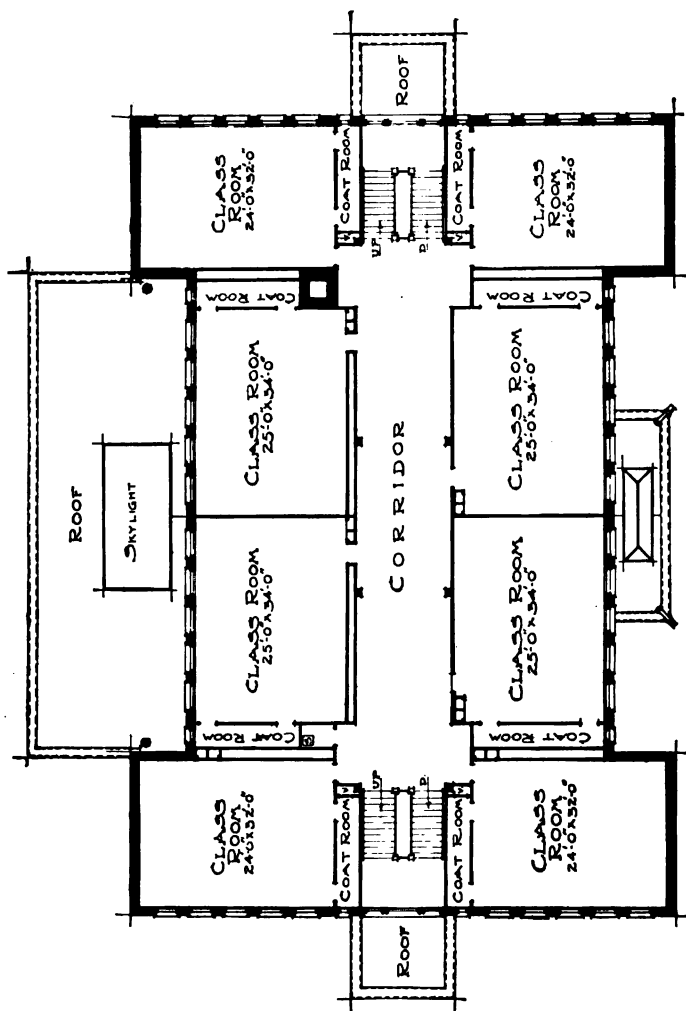
BASEMENT PLAN  
SCALE: 1/16" = 1'-0"

COLUMBIA SCHOOL, CLEVELAND. BASEMENT PLAN.



FIRST FLOOR PLAN  
SCALE  $\frac{1}{16}'' = 1'-0''$

COLUMBIA SCHOOL, CLEVELAND. FIRST-FLOOR PLAN.



SECOND FLOOR PLAN  
SCALE 1/8"=1'-0"

COLUMBIA SCHOOL, CLEVELAND. SECOND-FLOOR PLAN.



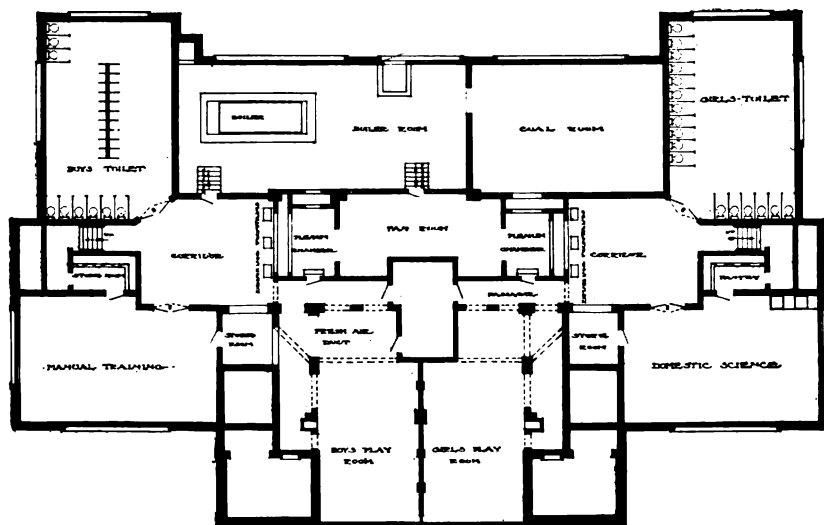
**A. DUANE DOTY SCHOOL, DETROIT, MICH. MALCOLMSON & HIGGINBOTHAM, ARCHITECTS.**



**B. JOHN GREUSEL SCHOOL, DETROIT, MICH. MALCOLMSON & HIGGINBOTHAM, ARCHITECTS.**

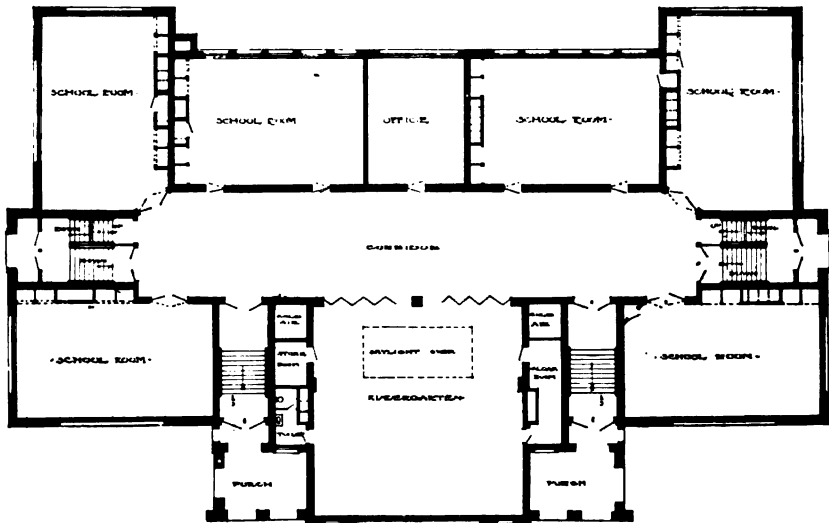


4. FANNY E. WINGERT SCHOOL, DETROIT, MICH. MALCOLMSON & HIGGINBOTHAM, ARCHITECTS.

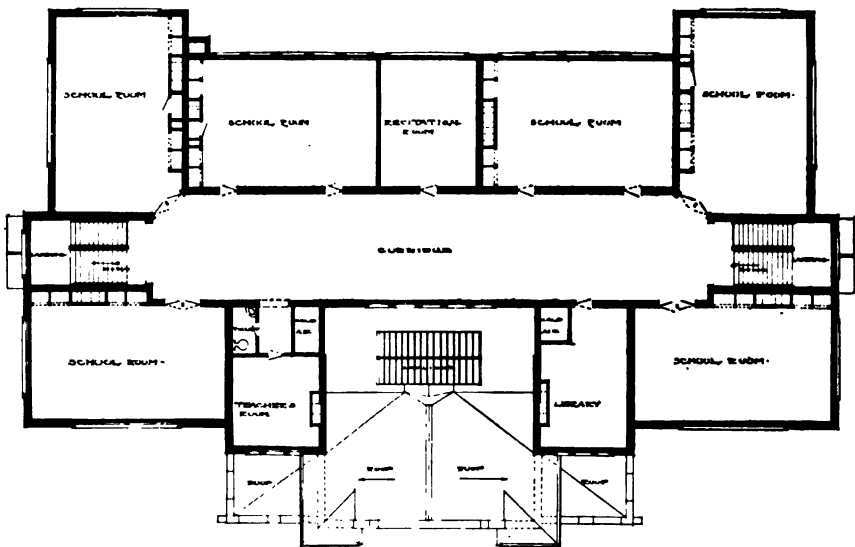


B. WINGERT SCHOOL, DETROIT. BASEMENT PLAN.





A. WINGERT SCHOOL, DETROIT. FIRST-FLOOR PLAN.



B. WINGERT SCHOOL, DETROIT. SECOND-FLOOR PLAN.



EVANS SCHOOL, DENVER, COLO. CONTAINS THE LATEST IDEAS IN DENVER SCHOOL CONSTRUCTION.



A. MARGARETTA SCHOOL, PITTSBURG, PA.



B. GEORGE F. SIMPSON SCHOOL, LOUISVILLE, KY.



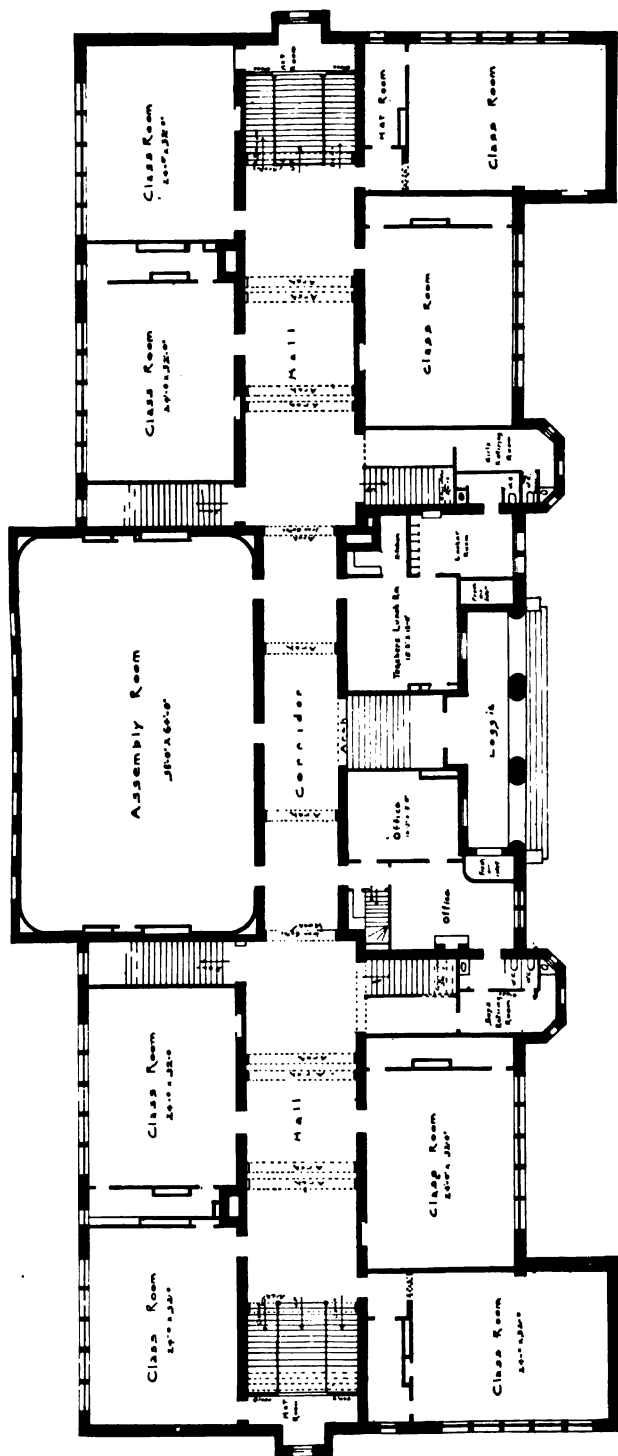
MONROE PRIMARY SCHOOL, STOCKTON, CAL. L. S. STONE, ARCHITECT. (SEE PAGE 125.)



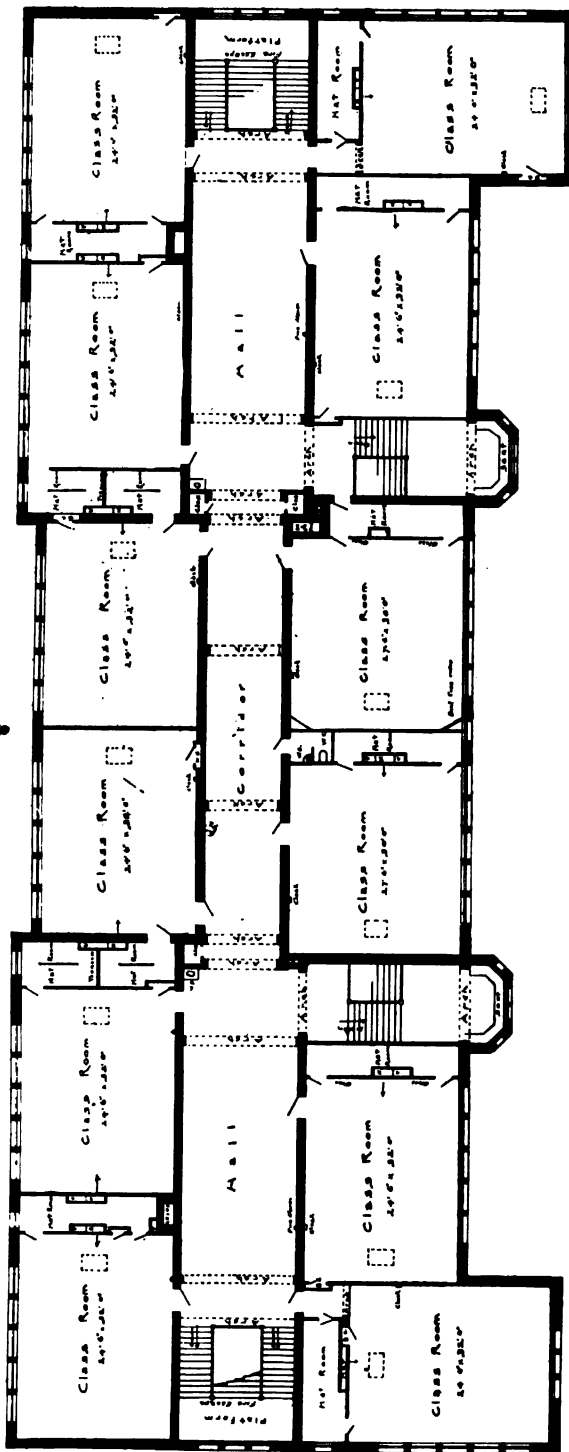
NEW GRAMMAR SCHOOL, POMONA, CAL. STONE & SMITH, ARCHITECTS. A GOOD EXAMPLE OF THE MISSION STYLE, WHICH IS COMING MORE AND MORE INTO USE IN CALIFORNIA. IT IS USUALLY OF ONE STORY, AND IS WELL ADAPTED TO THE SOUTHWESTERN LANDSCAPE AND CLIMATE. (SEE PAGE 125.)



FRANKLIN SCHOOL, OAKLAND, CAL. STONE & SMITH, ARCHITECTS.



FRANKLIN SCHOOL, OAKLAND. FIRST-FLOOR PLAN.

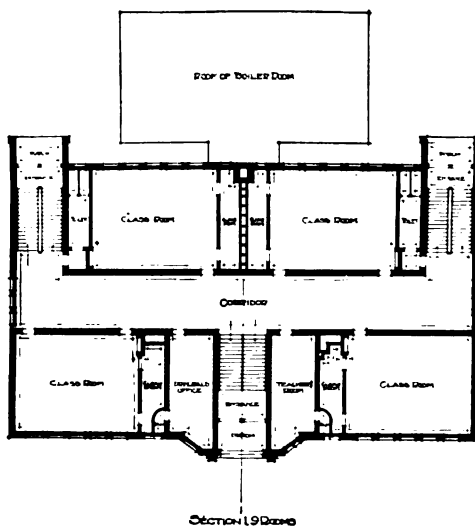


FRANKLIN SCHOOL, OAKLAND. SECOND-FLOOR PLAN.

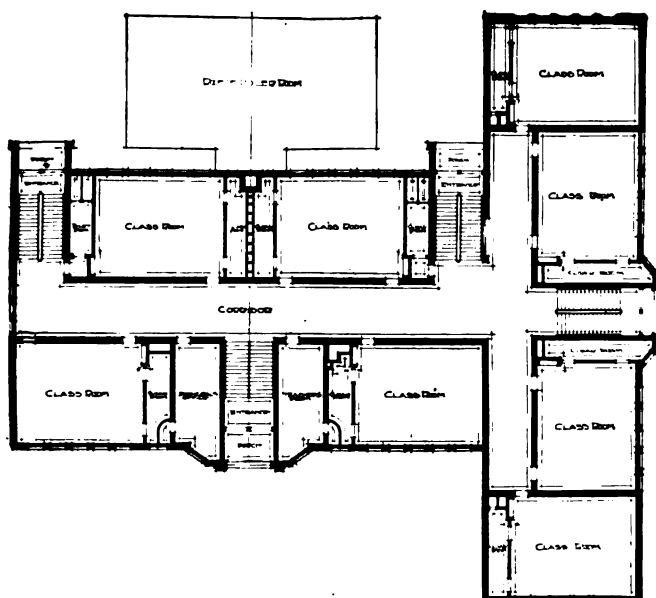




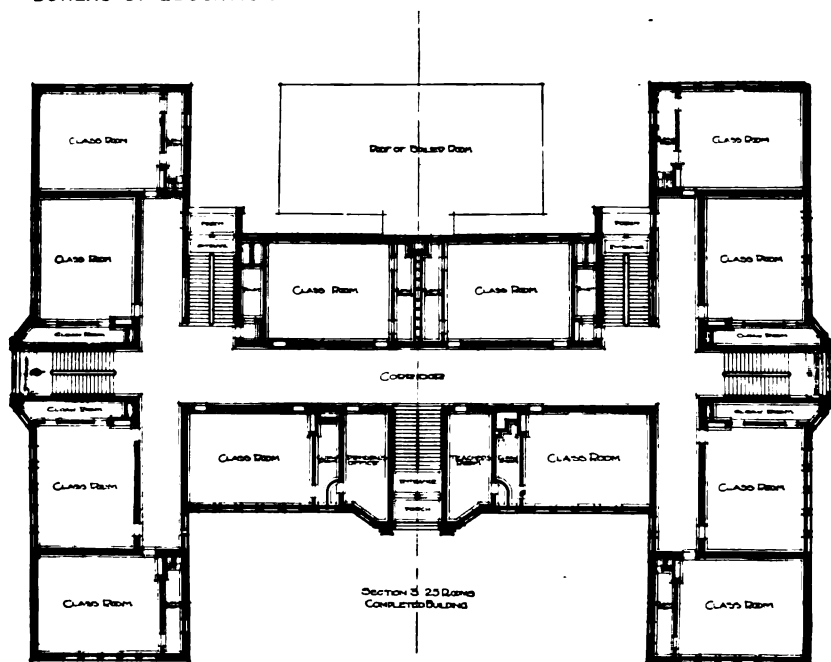
GRANT SCHOOL, OAKLAND, CAL. STONE & SMITH, ARCHITECTS. (SEE PAGE 125.)



A. STANDARD FLOOR PLAN OF SEATTLE (WASH.) ELEMENTARY SCHOOLS. FIRST STAGE OF CONSTRUCTION.



B. STANDARD FLOOR PLAN OF SEATTLE (WASH.) ELEMENTARY SCHOOLS SECOND STAGE OF CONSTRUCTION. (SEE PAGE 125.)



A. STANDARD FLOOR PLAN OF SEATTLE (WASH.) ELEMENTARY SCHOOLS.  
THIRD STAGE OF CONSTRUCTION. (SEE PAGE 125.)



B. ADAMS SCHOOL, SEATTLE, WASH. A BUILDING IN THE SECOND STAGE OF  
CONSTRUCTION. (SEE PAGE 125.)



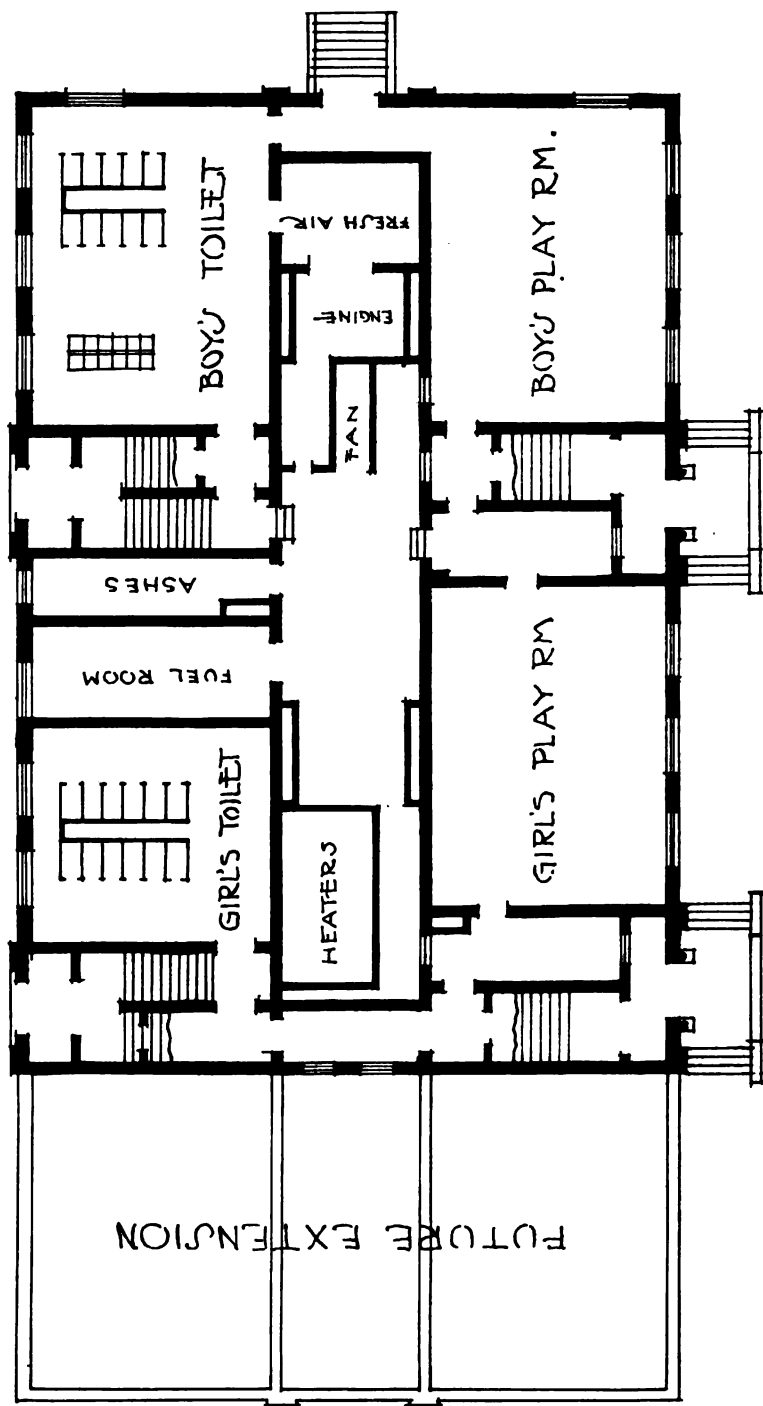
A. HAWTHORNE SCHOOL, SEATTLE, WASH. (SEE PAGE 125.)



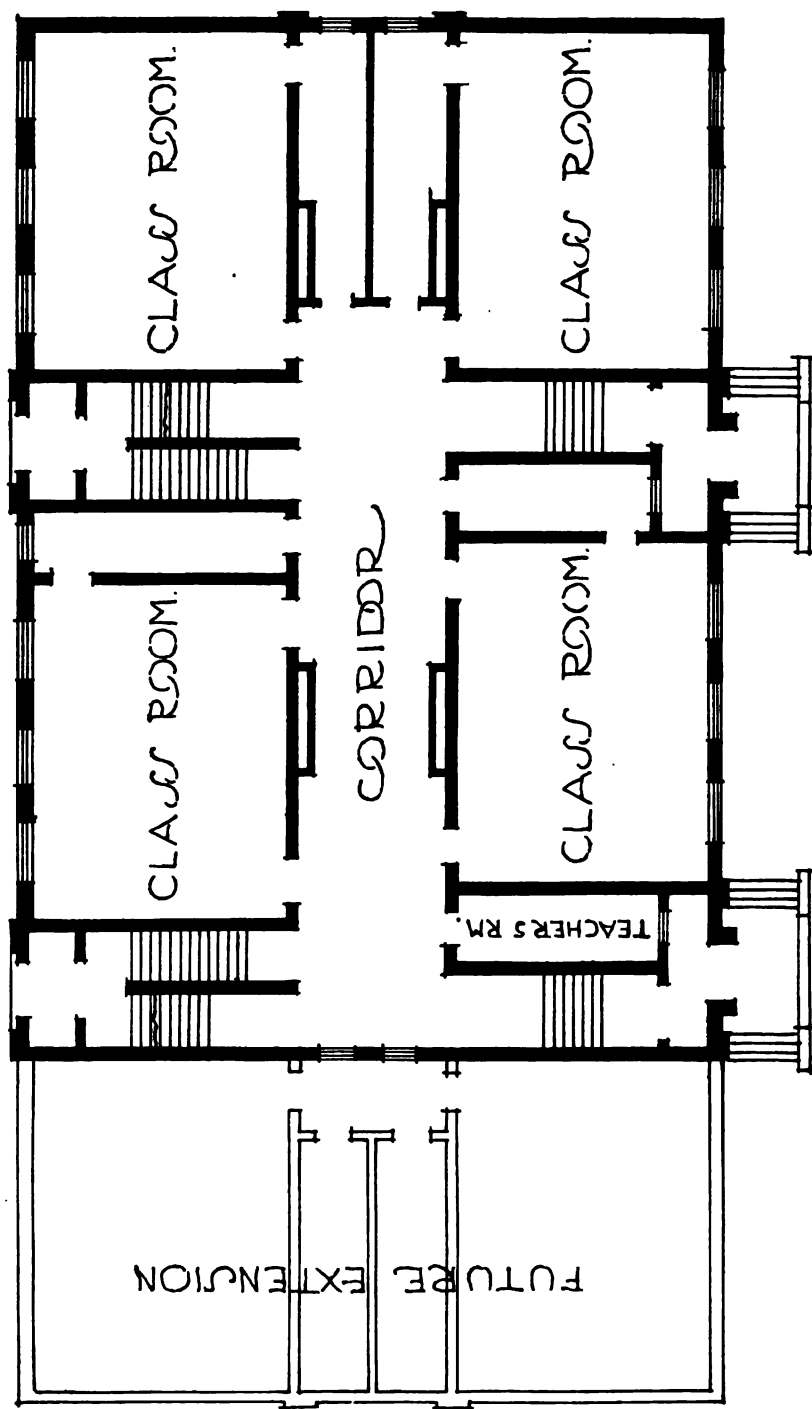
B. WHITWORTH SCHOOL, SEATTLE, WASH. BOTH BUILDINGS SHOWN ON THIS PAGE ARE IN THE FIRST STAGE OF CONSTRUCTION. SEE PLATE 194 FOR FLOOR PLAN.



LANGSTON SCHOOL, WASHINGTON, D. C. A. P. CLARK, JR., ARCHITECT.



LANGSTON SCHOOL, WASHINGTON. BASEMENT PLAN.

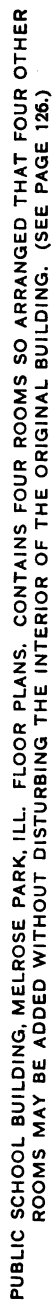


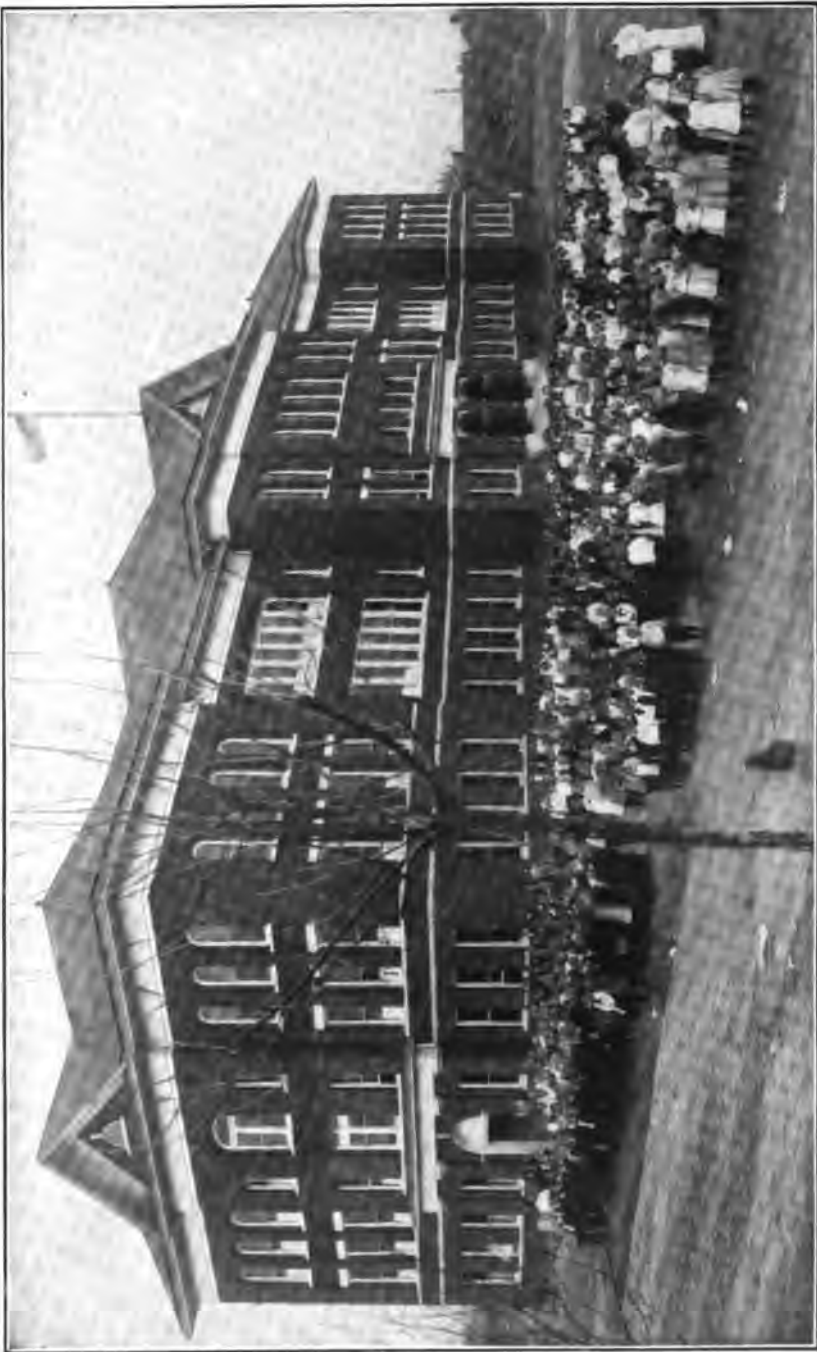
LANGSTON SCHOOL, WASHINGTON. FIRST-FLOOR PLAN. SECOND FLOOR SIMILAR.



PUBLIC SCHOOL BUILDING, MELROSE PARK, ILL. GEORGE ASHBY, ARCHITECT. (SEE PAGE 126.)  
(Through the courtesy of the School Board Journal.)



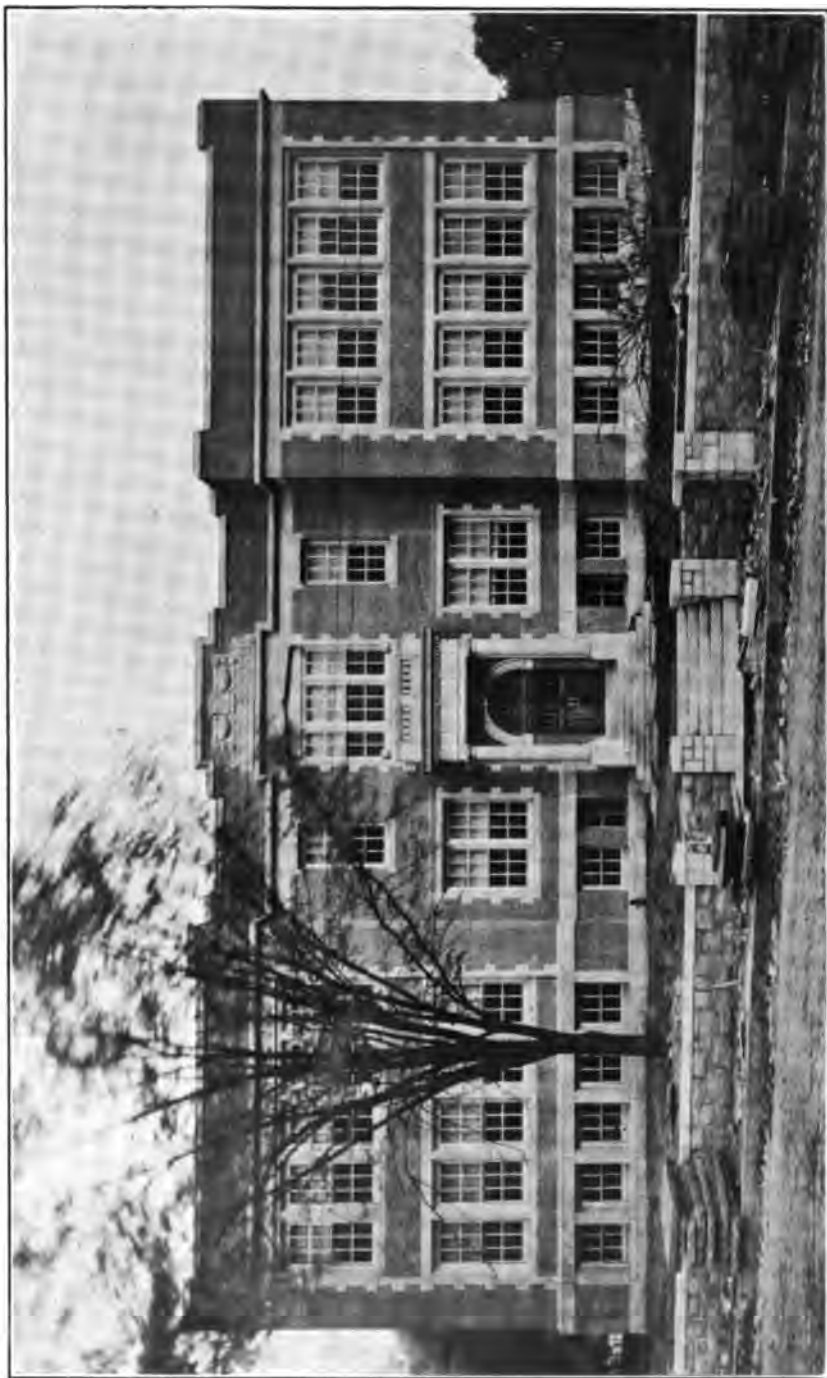




JOHN MILLEDGE SCHOOL, AUGUSTA, GA. CONTAINS 25 SCHOOLROOMS AND AN AUDITORIUM AND IS EQUIPPED FOR MANUAL TRAINING AND DOMESTIC SCIENCE INSTRUCTION.



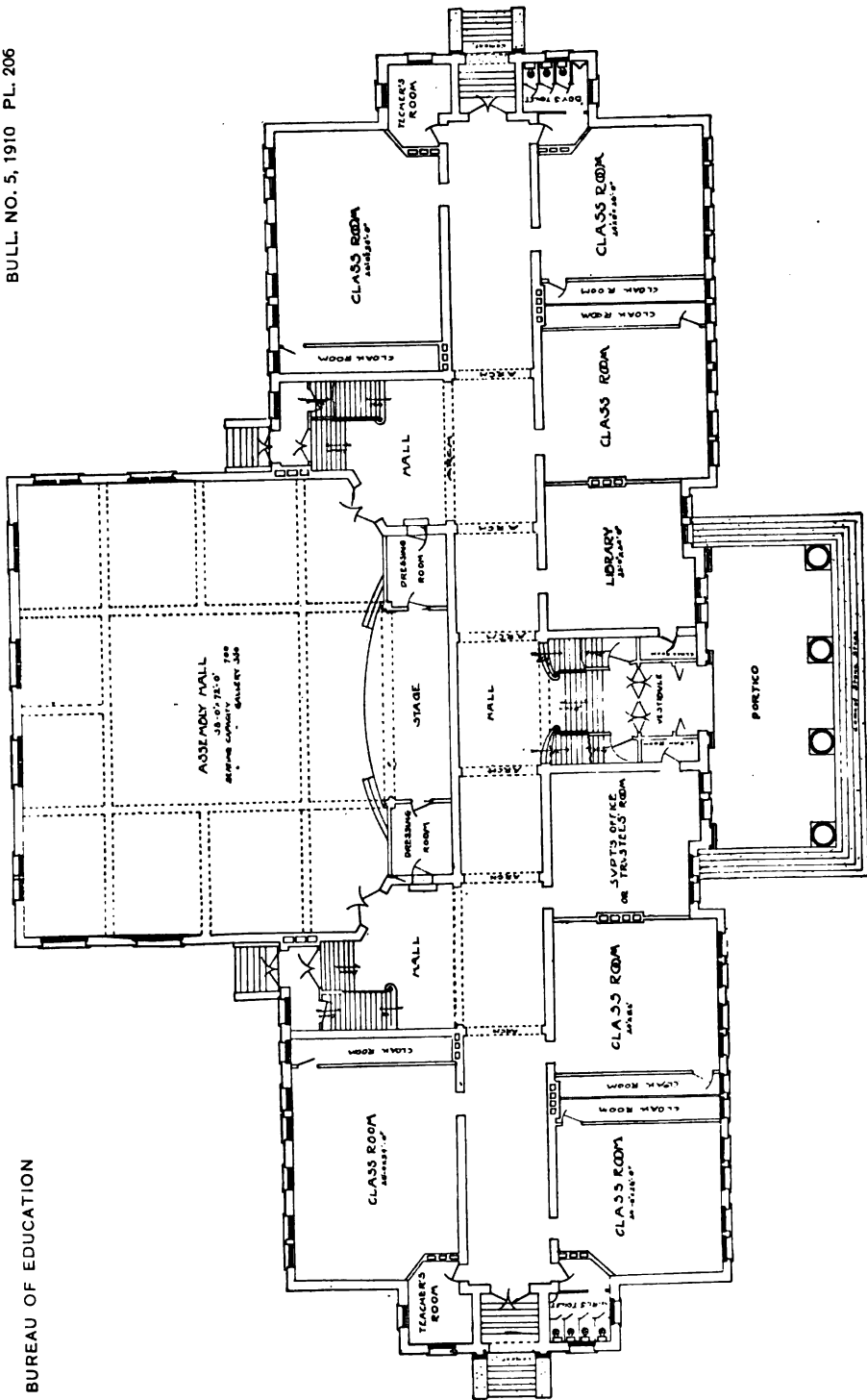
JOHN MILLEDGE SCHOOL, AUGUSTA. COOKING DEPARTMENT. AN EVIDENCE OF THE NEW SOUTH.



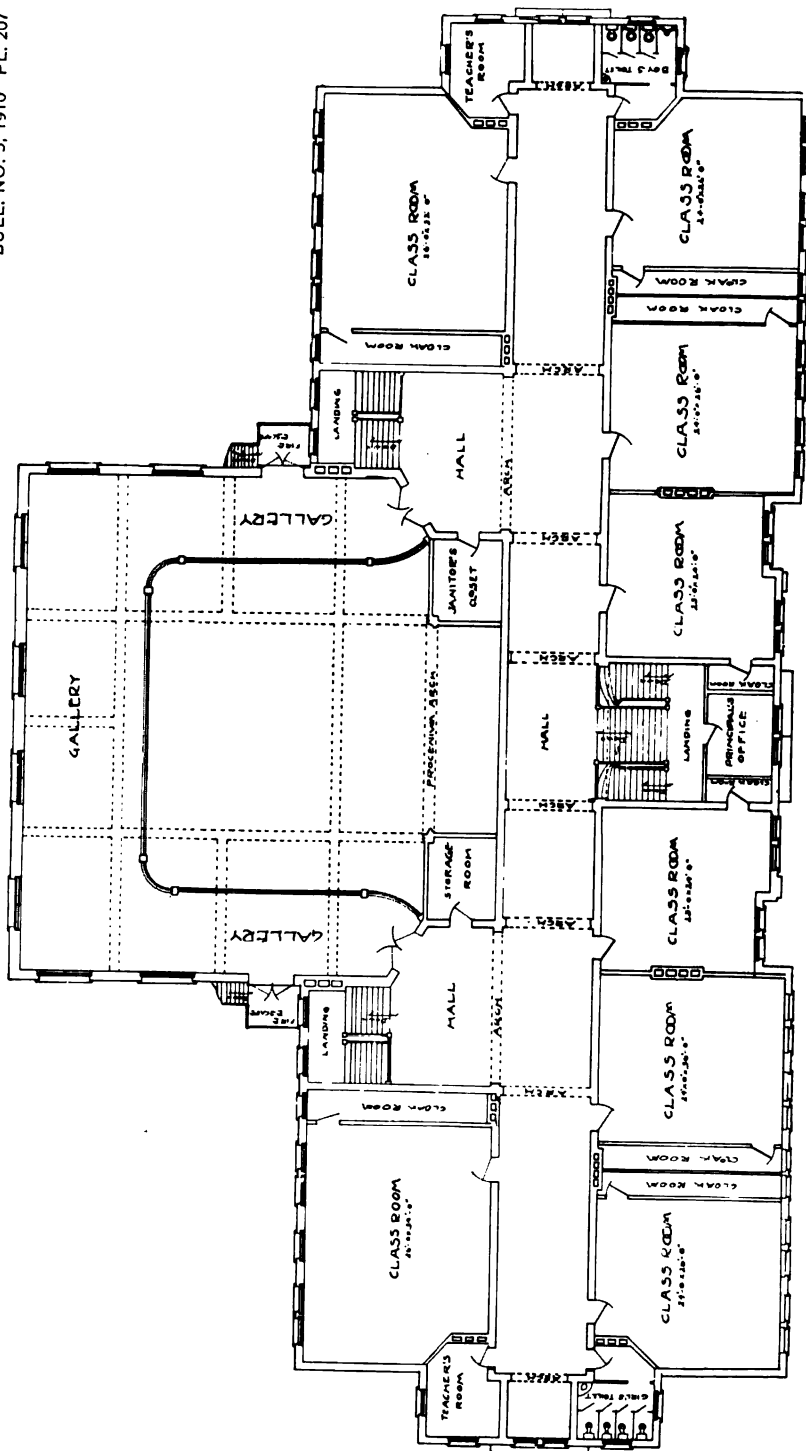
MODEL SCHOOL, STATE NORMAL SCHOOL, WILLIMANTIC, CONN. DAVIS & BROOKS, ARCHITECTS.



RISON PARK PUBLIC SCHOOL, DANVILLE, VA.



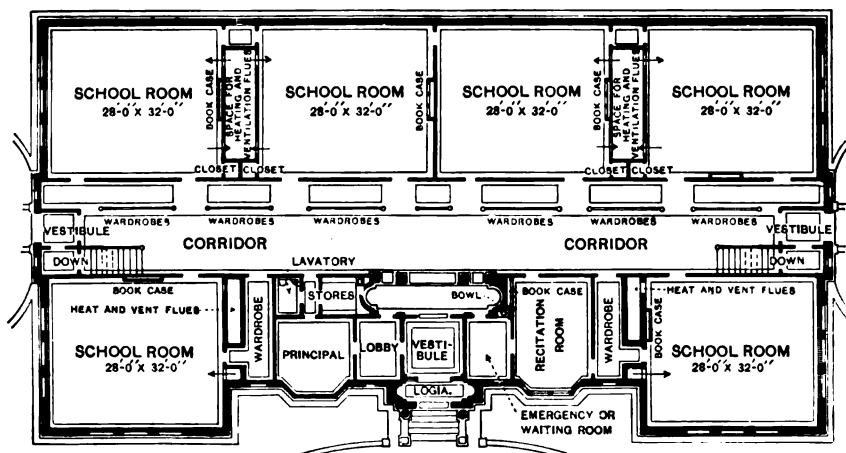
RISON PARK PUBLIC SCHOOL, DANVILLE. FIRST-FLOOR PLAN.



RISON PARK PUBLIC SCHOOL, DANVILLE. SECOND-FLOOR PLAN.



A. WINSLOW SCHOOL, BEVERLY, MASS. COOPER & BAILEY, ARCHITECTS.

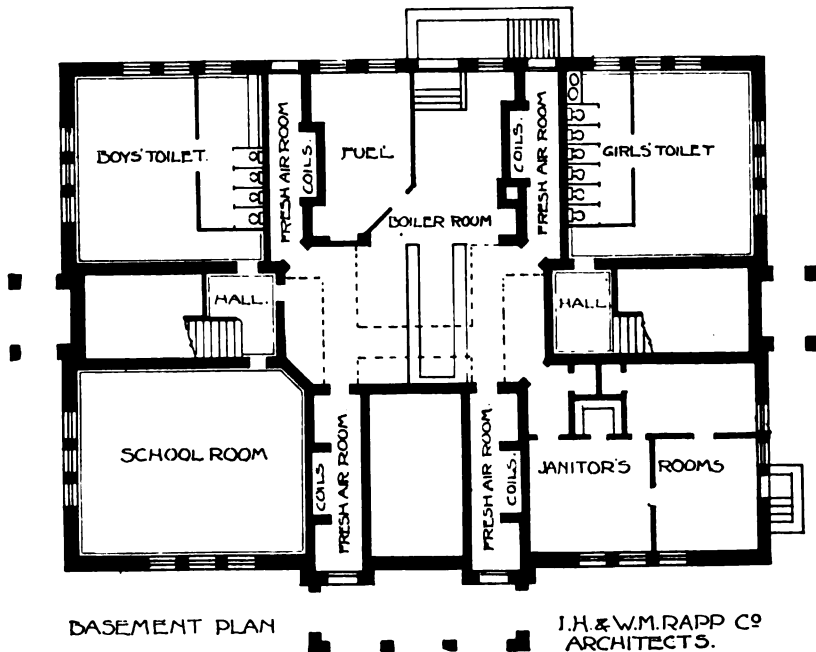


B. WINSLOW SCHOOL, BEVERLY. FIRST-FLOOR PLAN.

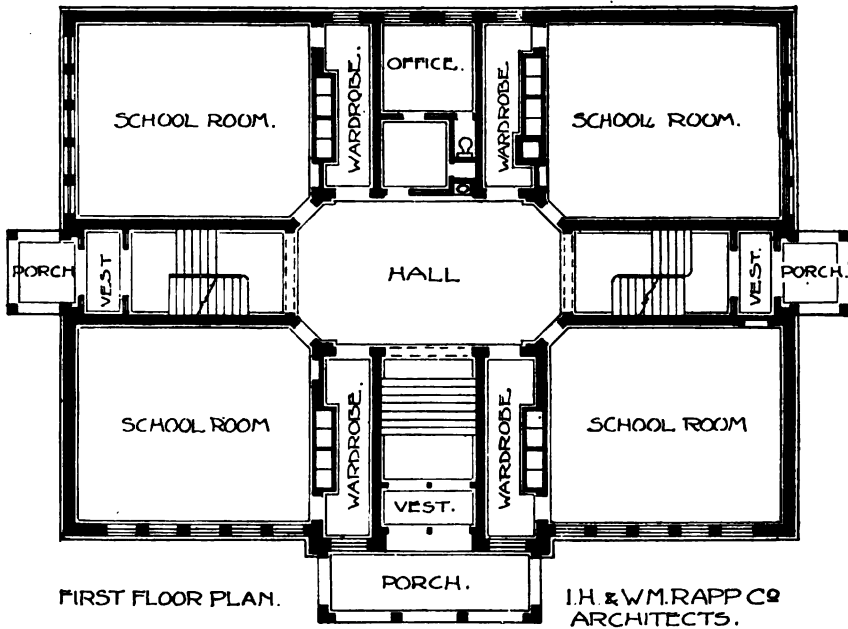




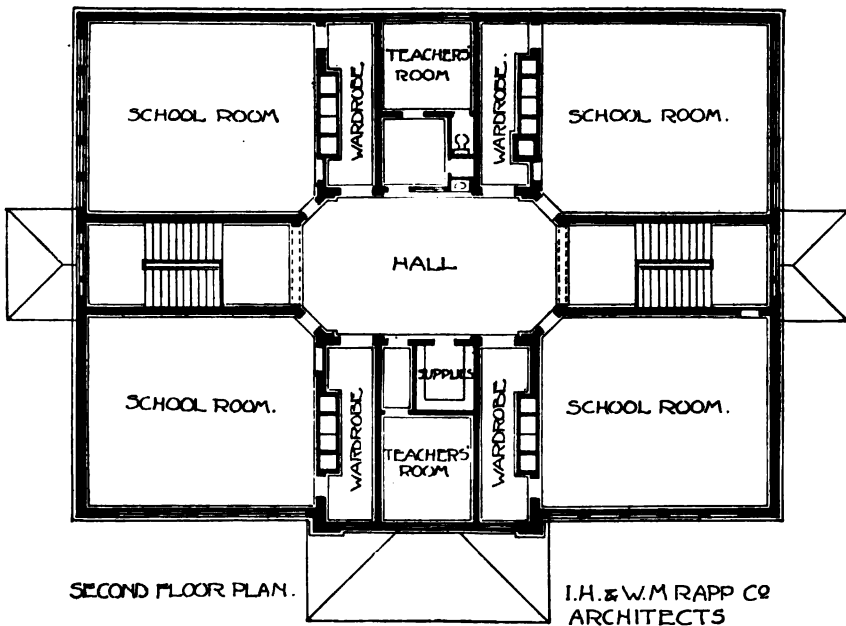
A. CENTENNIAL SCHOOL, TRINIDAD, COLO. I. H. & WM. RAPP CO. ARCHITECTS.



B. CENTENNIAL SCHOOL, TRINIDAD. BASEMENT PLAN.



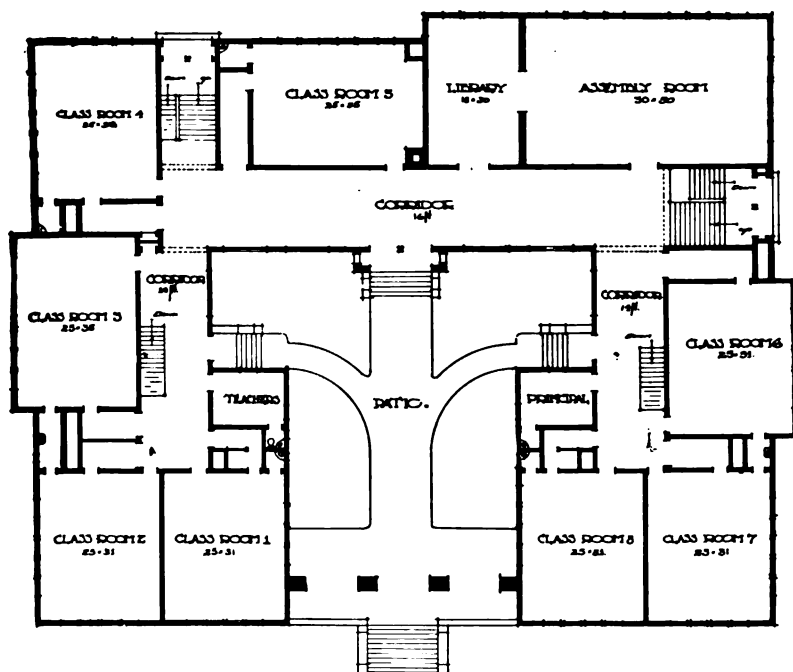
A. CENTENNIAL SCHOOL, TRINIDAD. FIRST-FLOOR PLAN.



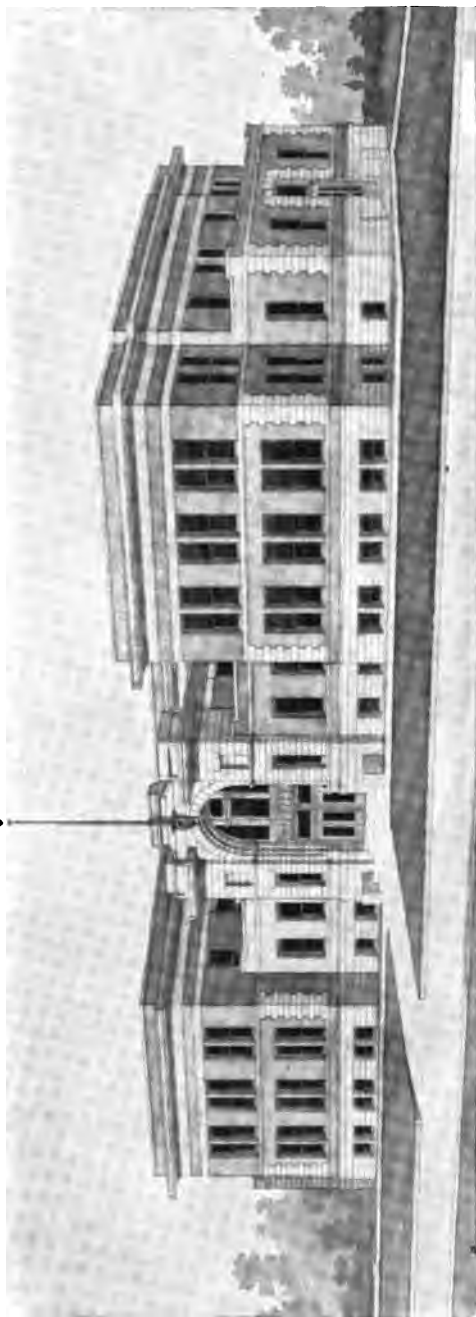
**B. CENTENNIAL SCHOOL, TRINIDAD. SECOND-FLOOR PLAN.**



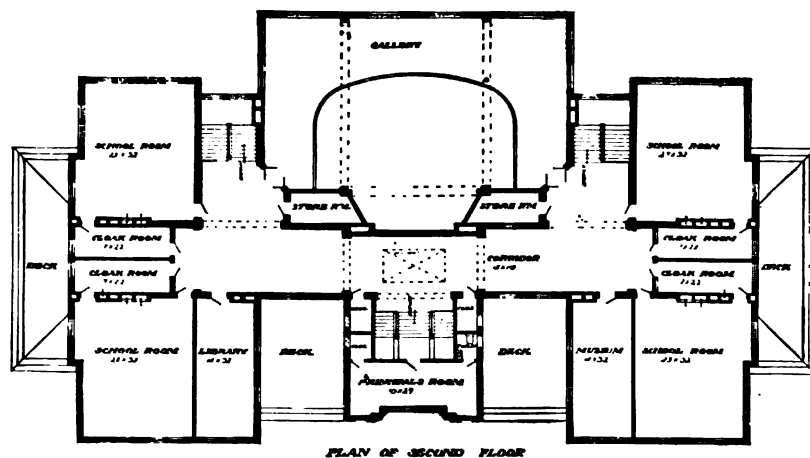
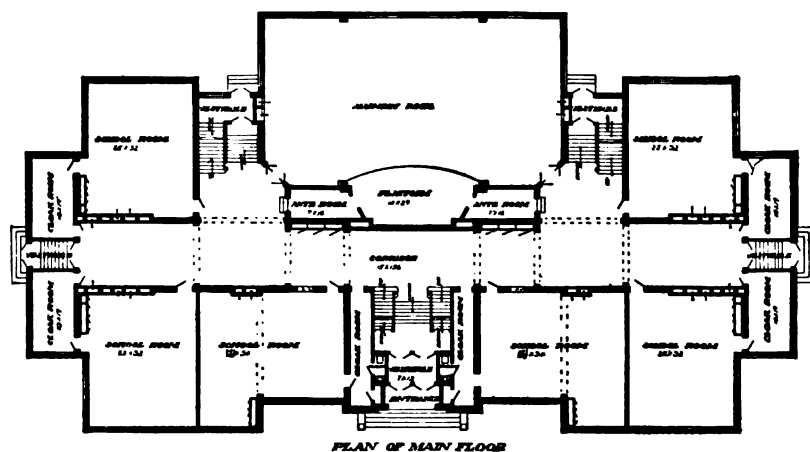
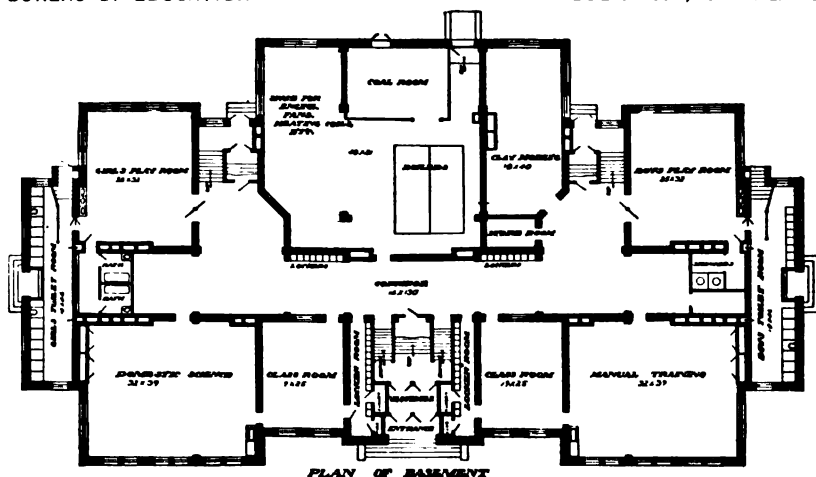
A. THOMAS JEFFERSON SCHOOL, PASADENA, CAL.



B. JEFFERSON SCHOOL, PASADENA. FLOOR PLAN.



NEW SCHOOL BUILDING, HAMILTON, OHIO. GEORGE BARKMAN AND GEORGE ASHBY, ARCHITECTS. (SEE SCHOOL BOARD JOURNAL, FEBRUARY, 1908.)



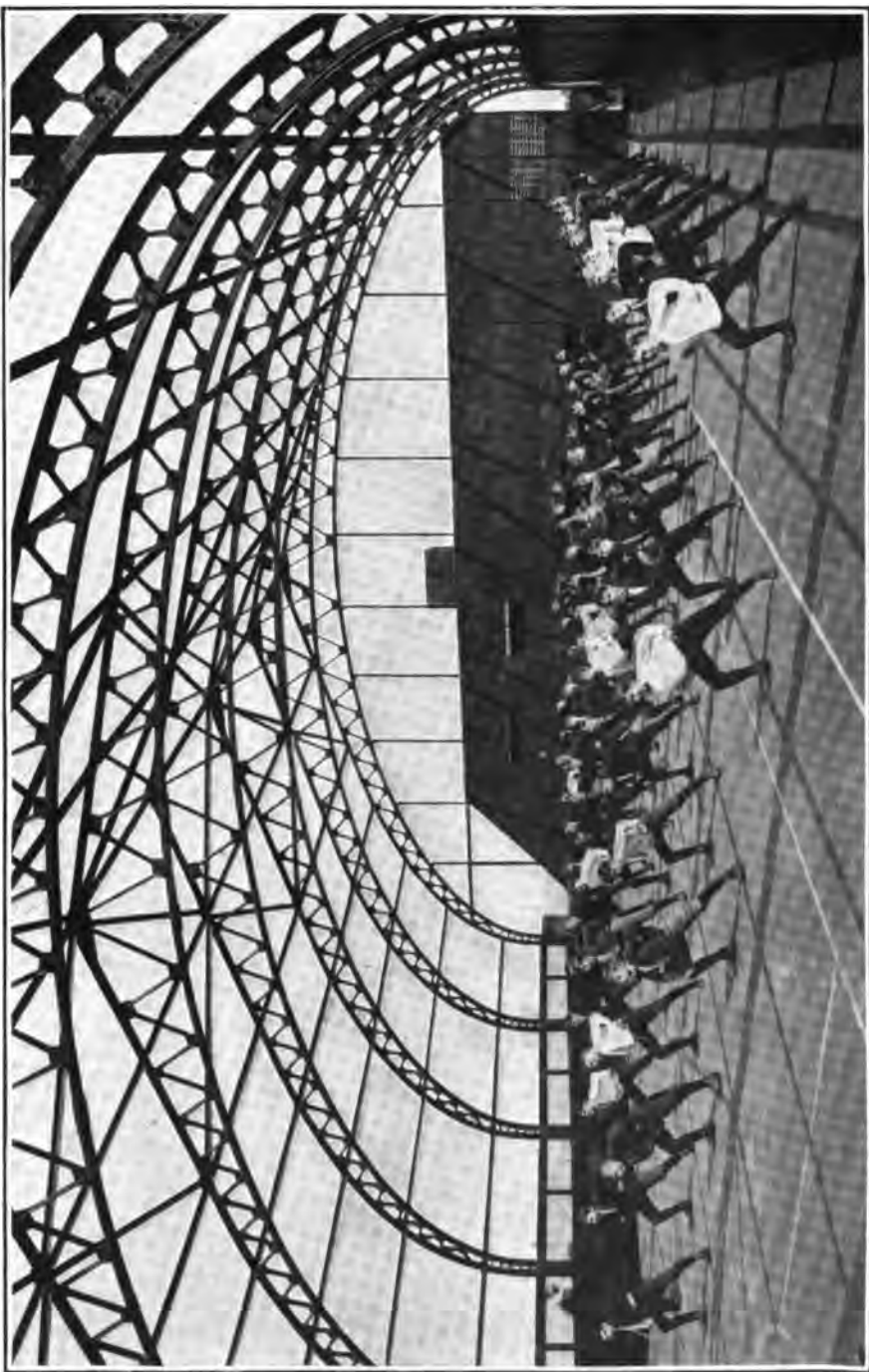
A, B, AND C.—NEW SCHOOL BUILDING, HAMILTON. FLOOR PLANS. (THROUGH THE COURTESY OF THE SCHOOL BOARD JOURNAL.)



ASHLAND (KY.) PUBLIC SCHOOL.



PUBLIC SCHOOL, SPRINGFIELD, MINN. NOTE THE GOOD PROPORTIONS AND THE TREATMENT OF THE BLANK WALLS. (SEE PAGE 124.)



ROOF PLAYGROUND, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT. MAKING GOOD USE OF SPACE PREVIOUSLY NEGLECTED.





A.—ROOF PLAYGROUND, HIGH SCHOOL, BALTIMORE, MD.



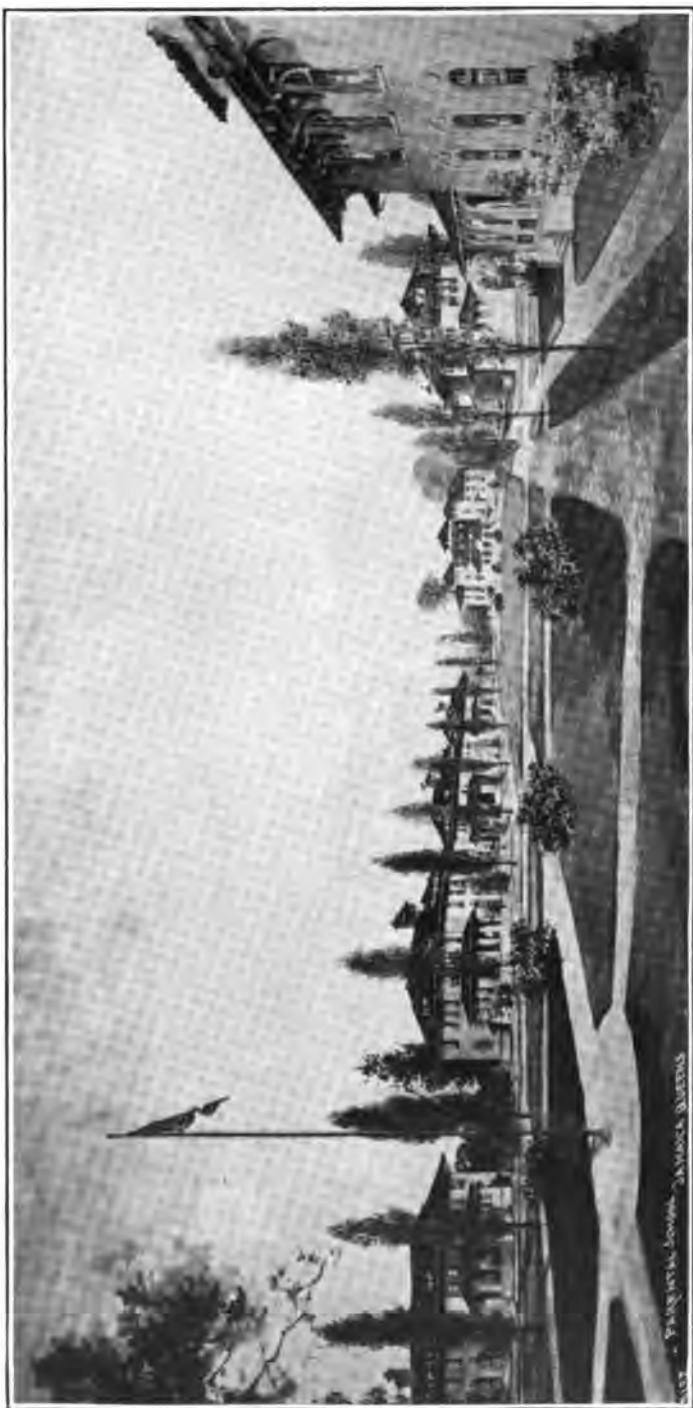
B.—PORTABLE SCHOOLHOUSE, BALTIMORE.



JESSE SPALDING SCHOOL FOR CRIPPLED CHILDREN, CHICAGO, ILL. D. H. PERKINS, ARCHITECT.



JESSE SPALDING SCHOOL FOR CRIPPLED CHILDREN, CHICAGO. GOING HOME.



PARENTAL HOME SCHOOL, FLUSHING, NEW YORK CITY. C. B. J. SNYDER, ARCHITECT. GENERAL VIEW.



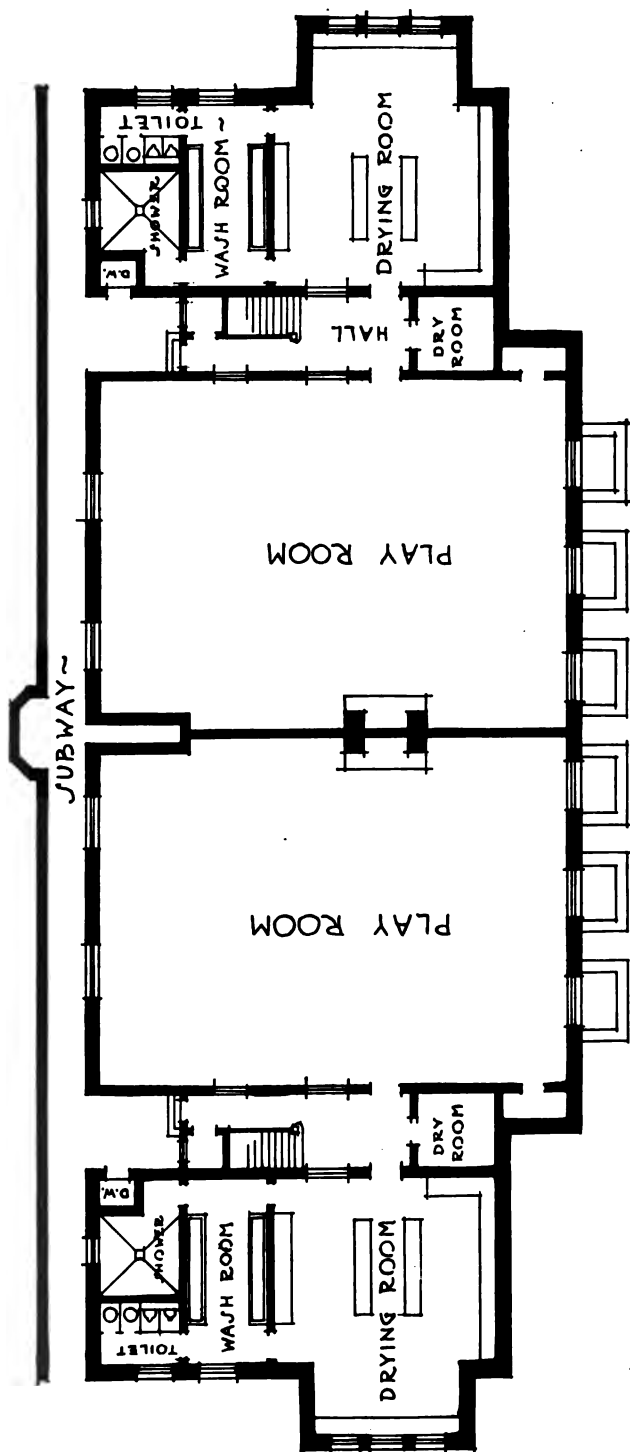
PARENTAL HOME SCHOOL. NEW YORK CITY. ADMINISTRATION BUILDING. C. B. J. SNYDER, ARCHITECT.



PARENTAL HOME SCHOOL, NEW YORK CITY. ASSEMBLY ROOM. ADMINISTRATION BUILDING.

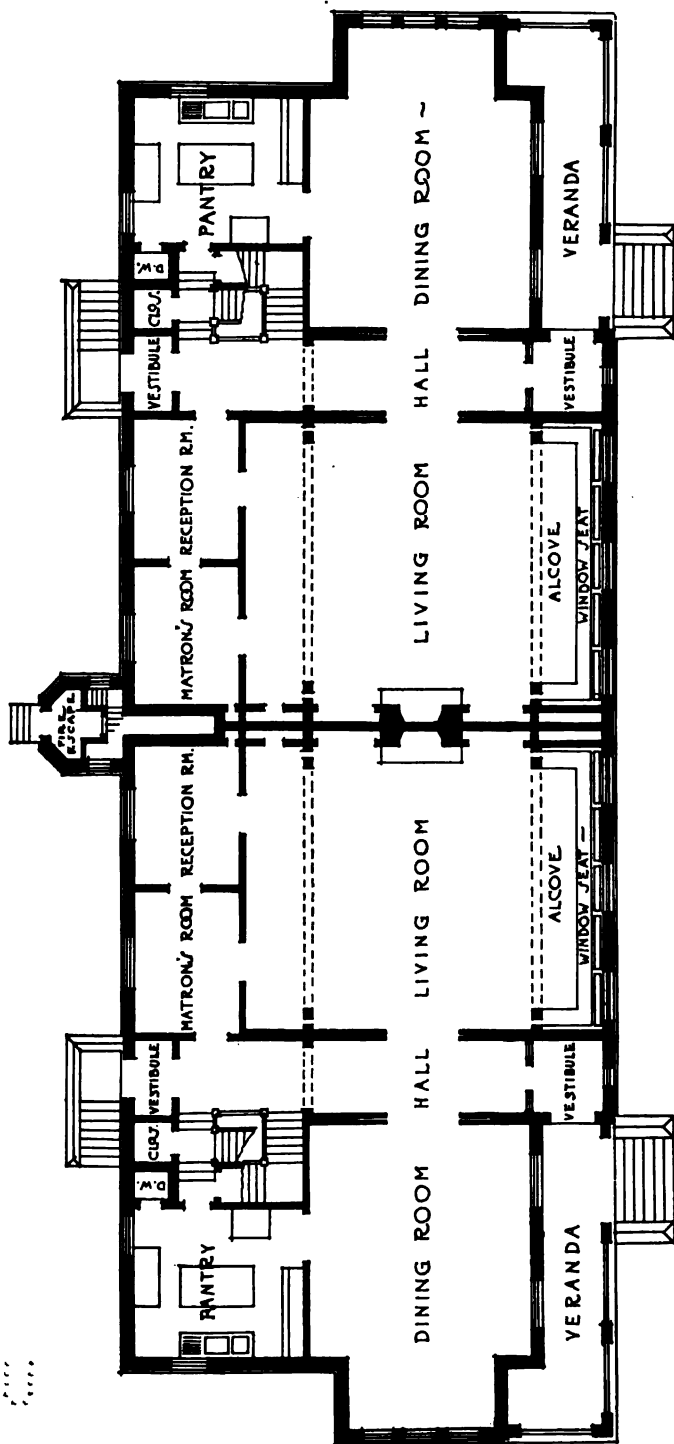


PARENTAL HOME SCHOOL, NEW YORK CITY. A ROW OF DORMITORIES.

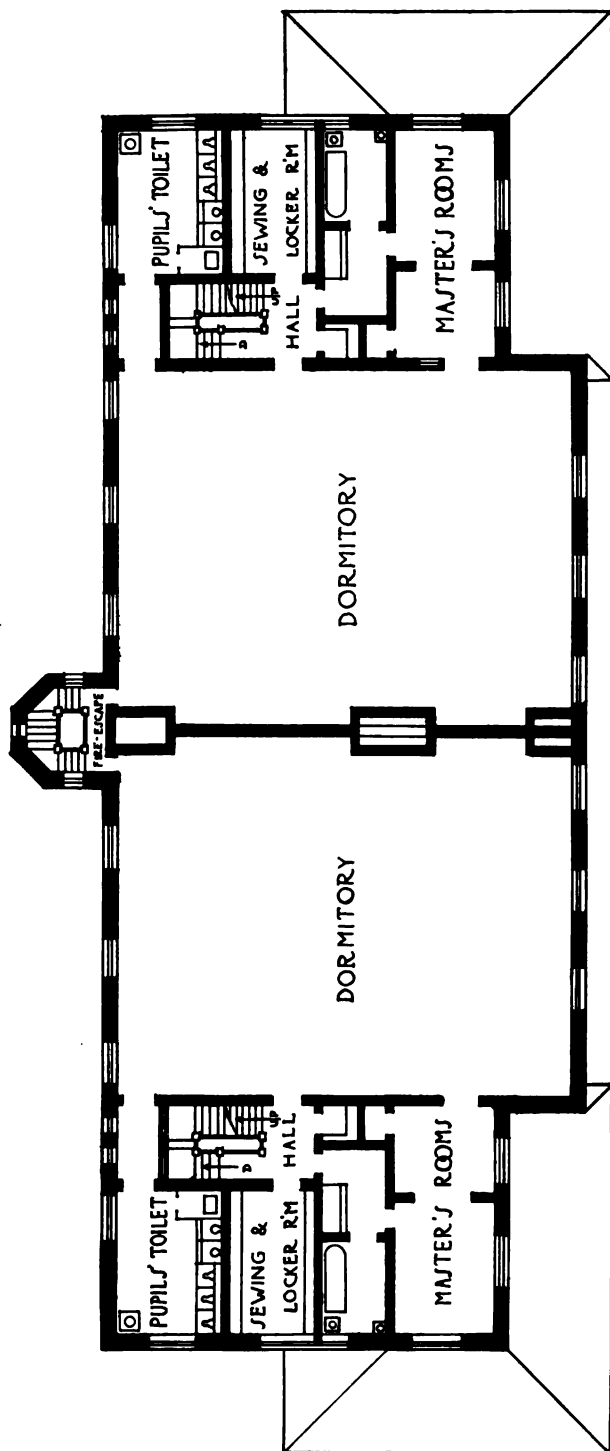


PARENTAL HOME SCHOOL, NEW YORK CITY. TYPICAL BASEMENT PLAN. DORMITORY BUILDING.





PARENTAL HOME SCHOOL, NEW YORK CITY. TYPICAL FIRST-FLOOR PLAN, DORMITORY BUILDING.



PARENTAL HOME SCHOOL, NEW YORK CITY. TYPICAL SECOND-FLOOR PLAN, DORMITORY BUILDING.



**A. BARNSELY GIRLS' HIGH SCHOOL, YORKSHIRE, ENGLAND.**



**B. GOOLE SECONDARY SCHOOL (DUAL), YORKSHIRE, ENGLAND.**



**A. DEWSBURY TECHNICAL SCHOOL, YORKSHIRE, ENGLAND.**



**B. MYRTLE PARK COUNCIL SCHOOL (ELEMENTARY), BINGLEY, YORKSHIRE, ENGLAND.**



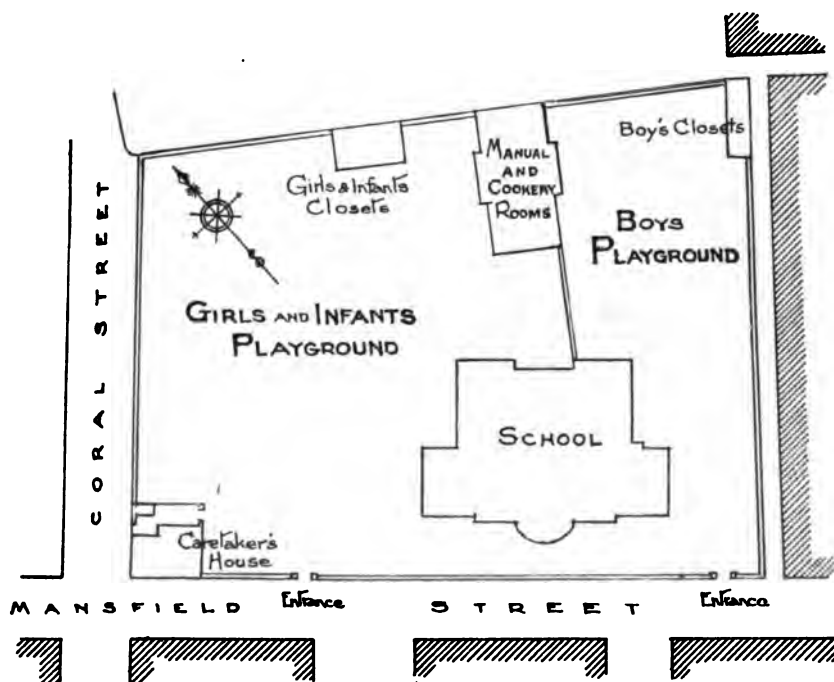
**A. THORNTON-IN-CRAVEN COUNCIL SCHOOL, YORKSHIRE, ENGLAND. A  
SMALL RURAL SCHOOL.**



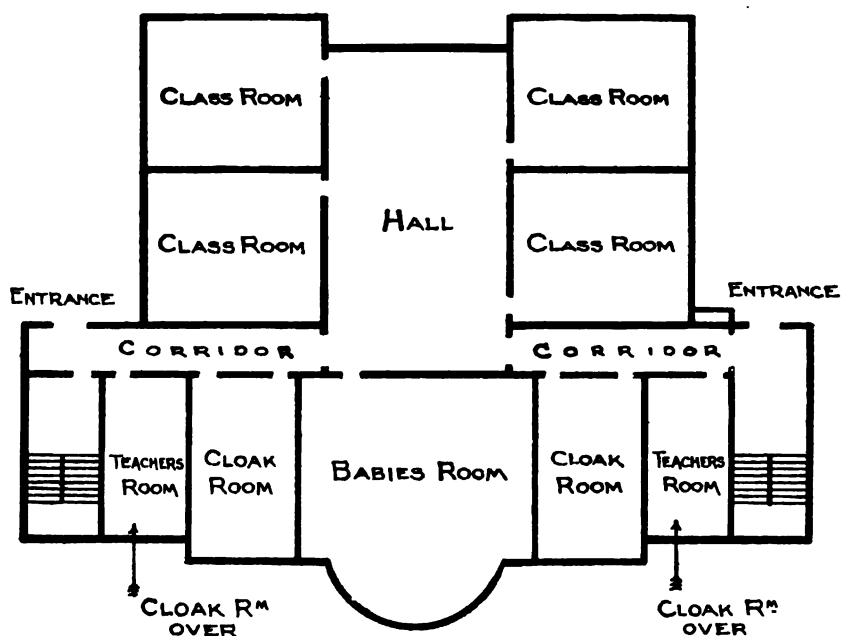
**B. MANSFIELD STREET SCHOOL, MANCHESTER, ENGLAND.**



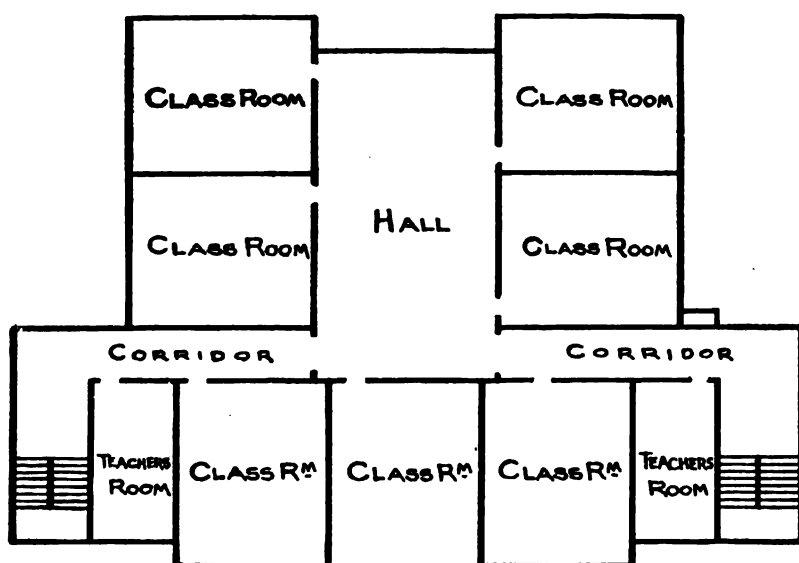
A. MANSFIELD STREET SCHOOL, MANCHESTER, ENGLAND. BABIES' CLASS-ROOM.



B. MANSFIELD STREET SCHOOL, MANCHESTER, ENGLAND. BLOCK PLAN.



A. MANSFIELD STREET SCHOOL, MANCHESTER, ENGLAND. FIRST-FLOOR PLAN.



B. MANSFIELD STREET SCHOOL, MANCHESTER, ENGLAND. SECOND-FLOOR PLAN.



PRIMARY COMMUNAL SCHOOL OF DIEPENBECK, PROVINCE OF LIMBOURG, BELGIUM.

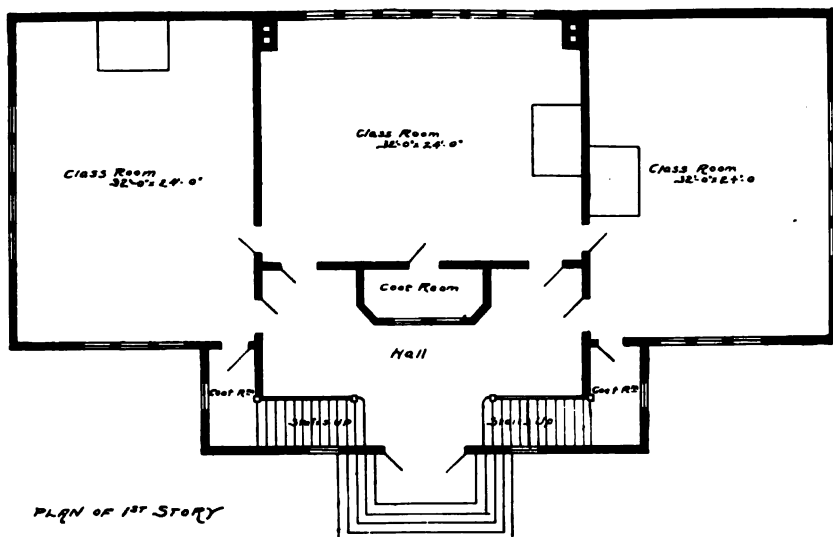




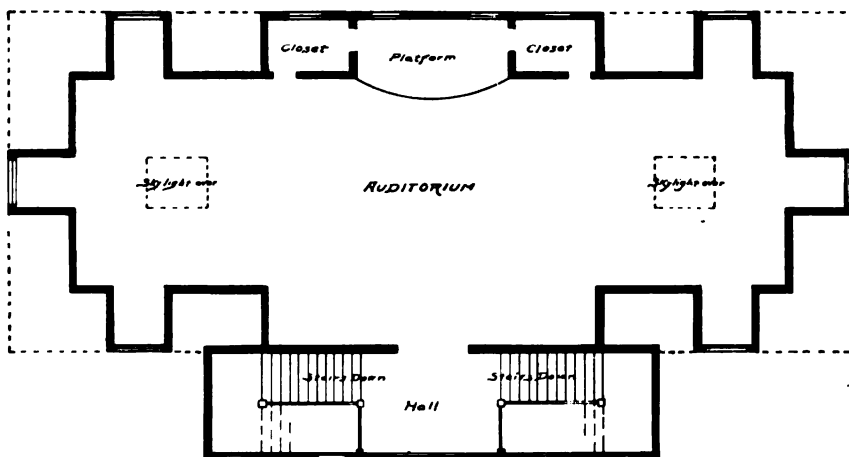
A. ALABAMA STANDARD SCHOOLHOUSE DESIGN. ELEVATIONS.



B. ALABAMA STANDARD SCHOOLHOUSE DESIGN. ELEVATIONS.



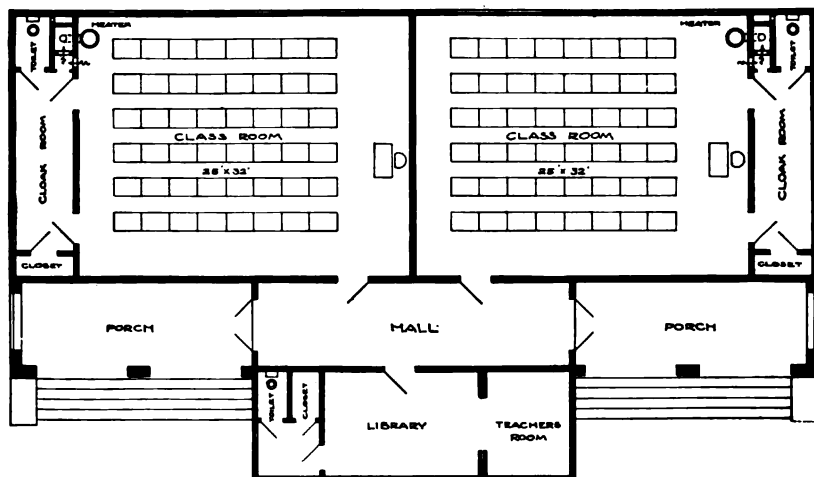
A. ALABAMA STANDARD SCHOOLHOUSE DESIGN. FIRST-FLOOR PLAN.



B. ALABAMA STANDARD SCHOOLHOUSE DESIGN. SECOND-FLOOR PLAN.



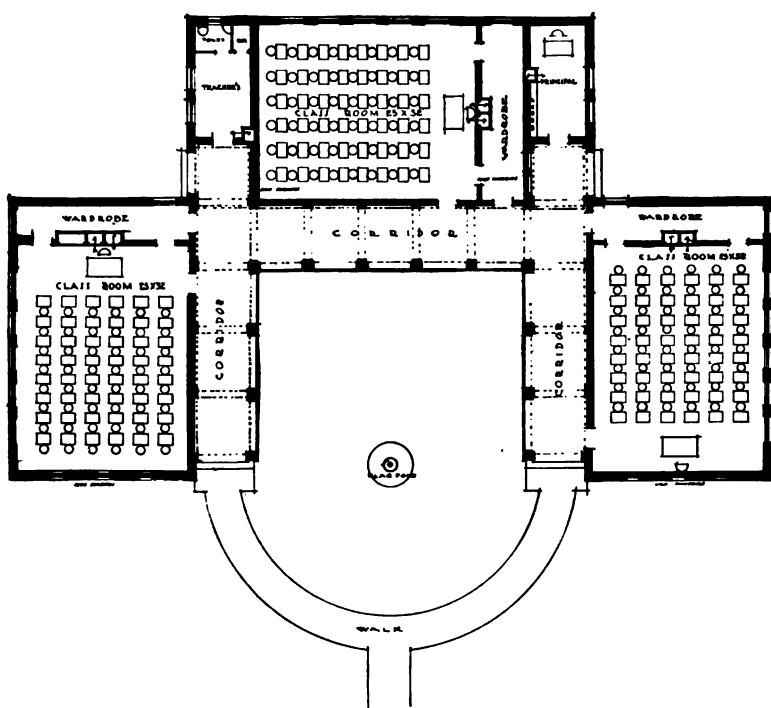
A. DESIGN FOR A TWO-ROOM BUILDING IN THE MISSION STYLE.  
W. H. WEEKS, ARCHITECT. (SEE PAGE 125.)



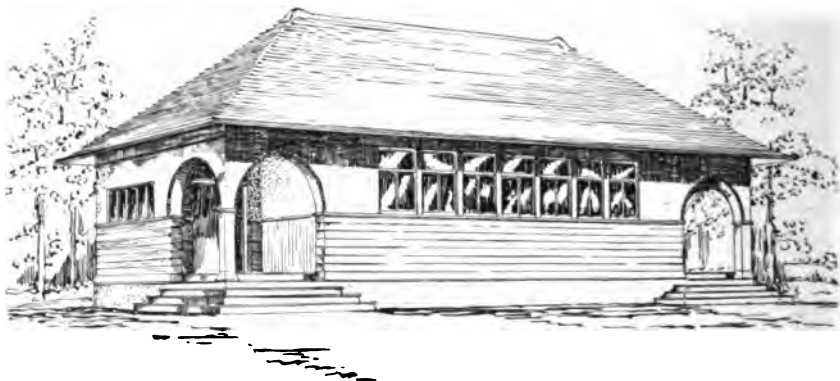
B. FLOOR PLAN OF THE SAME



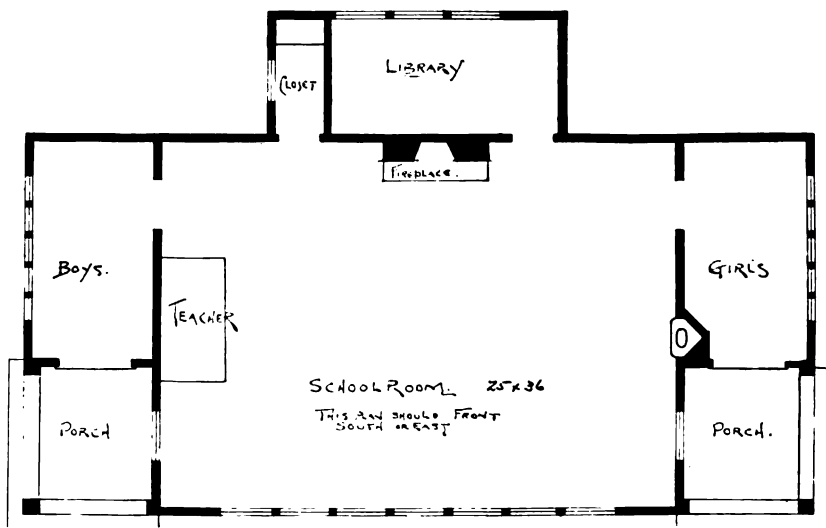
A. A CALIFORNIA THREE-ROOM SCHOOL IN THE MISSION STYLE.  
W. H. PARKER, ARCHITECT. (SEE PAGE 125.)



B. FLOOR PLAN OF THE SAME.



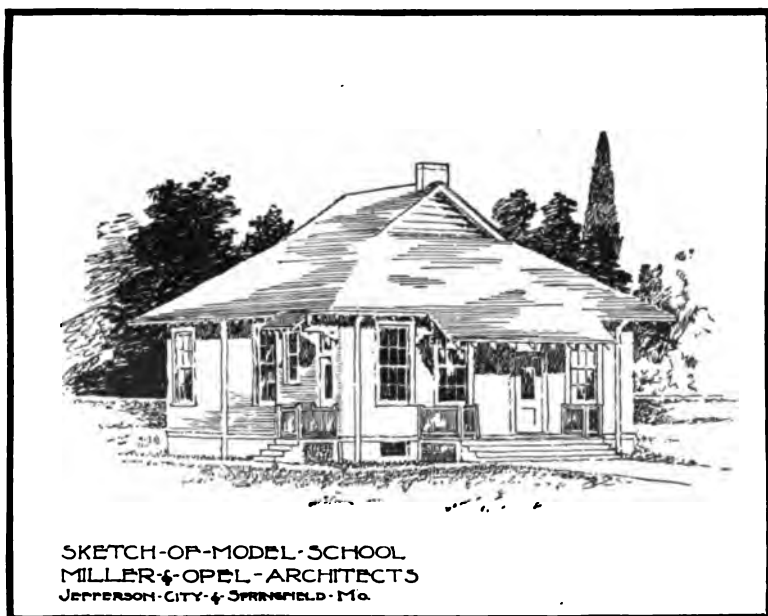
A. PERSPECTIVE OF A CALIFORNIA ONE-ROOM SCHOOLHOUSE. HENRY F. STARBUCK, ARCHITECT.



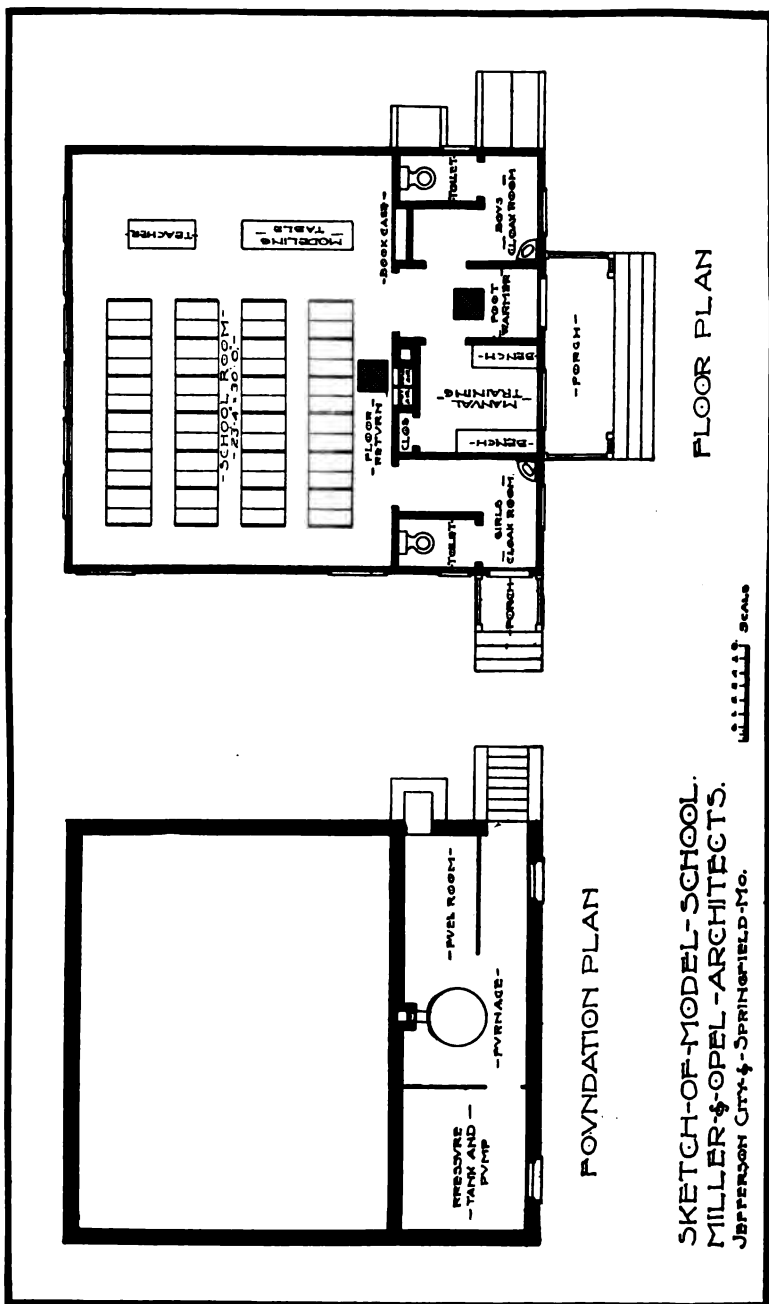
B. FLOOR PLAN OF A CALIFORNIA ONE-ROOM SCHOOLHOUSE. HENRY F. STARBUCK, ARCHITECT.



A. MODEL ONE-ROOM SCHOOLHOUSE, JAMESTOWN EXPOSITION, NORFOLK, VA. (THROUGH THE COURTESY OF THE SCHOOL BOARD JOURNAL.)



B. DESIGN FOR A TWO-ROOM SCHOOLHOUSE. MILLER & OPEL, ARCHITECTS.

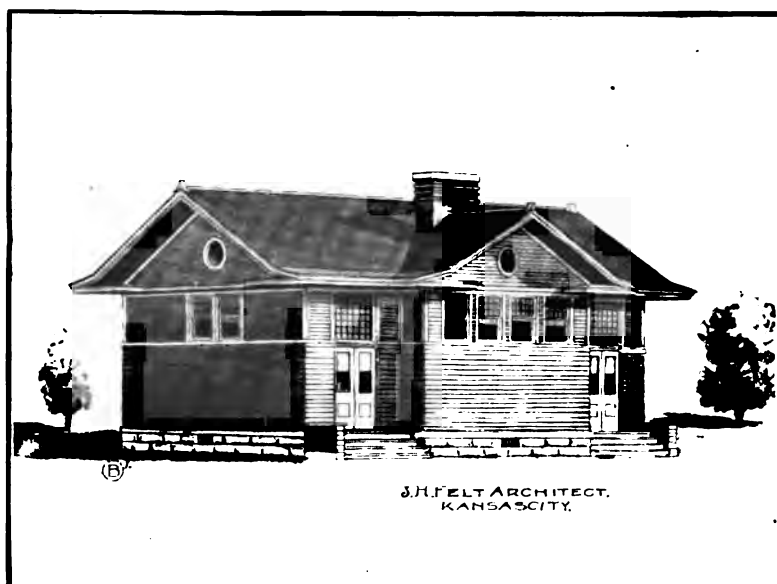


SKETCH-OF-MODEL-SCHOOL.  
MILLER-&OPEL-ARCHITECTS.  
JEFFERSON CITY-&-SPRINGFIELD-MO.

A AND B DESIGN FOR A ONE-ROOM SCHOOLHOUSE. FLOOR PLANS.

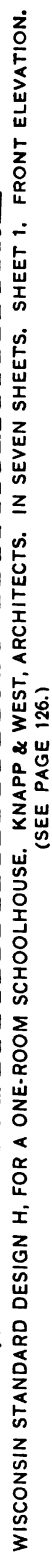


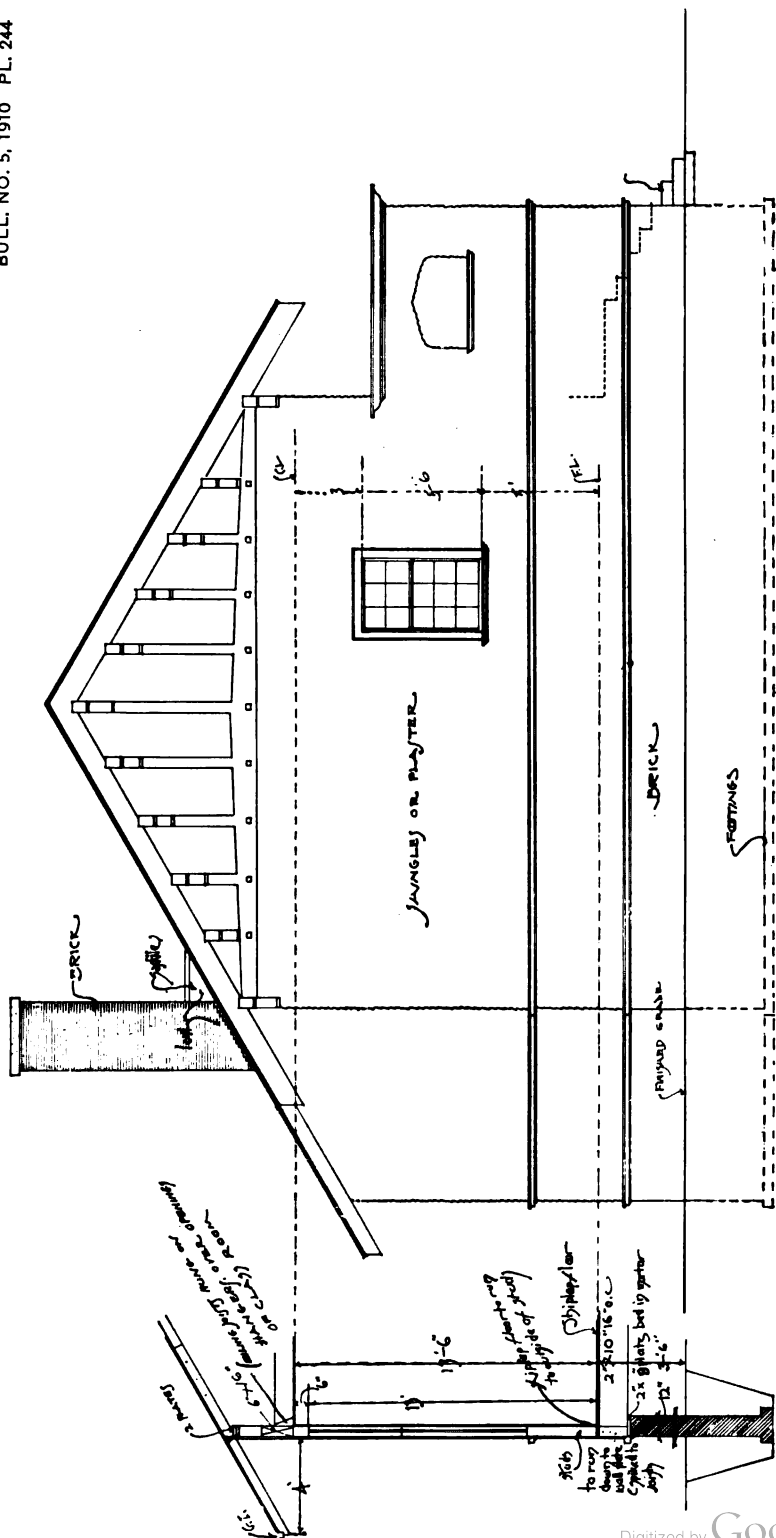
A. DESIGN FOR A TWO-ROOM SCHOOLHOUSE. J. H. FELT, ARCHITECT.



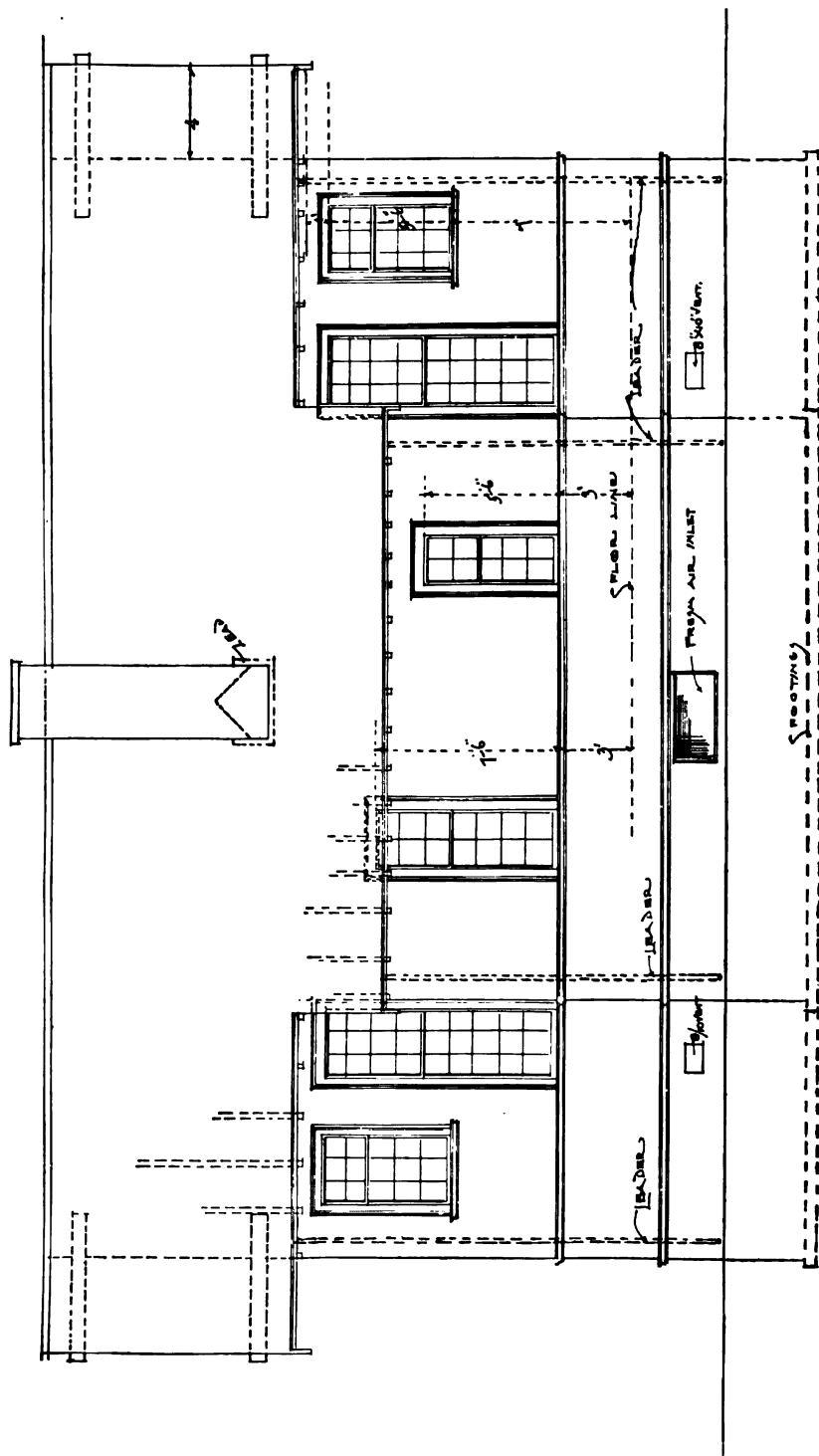
B. DESIGN FOR A TWO-ROOM SCHOOLHOUSE. J. H. FELT, ARCHITECT.





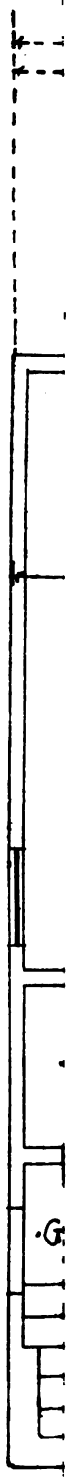


WISCONSIN STANDARD DESIGN H. SHEET 2. SIDE ELEVATION.



WISCONSIN STANDARD DESIGN H. SHEET 3. REAR ELEVATION.

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WISCONSIN STANDARD DESIGN H. SHEET 6. CROSS SECTION ON LINE AB.



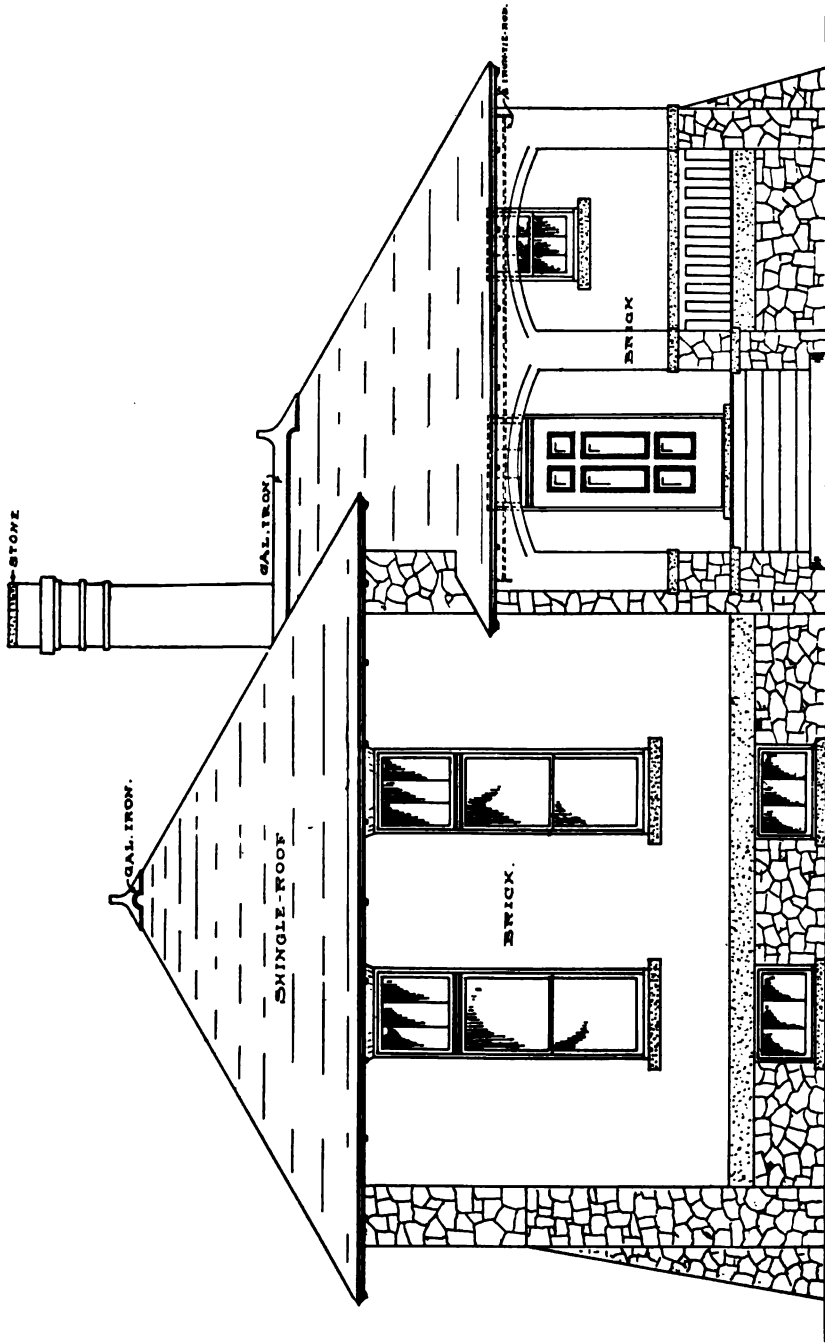


BUREAU

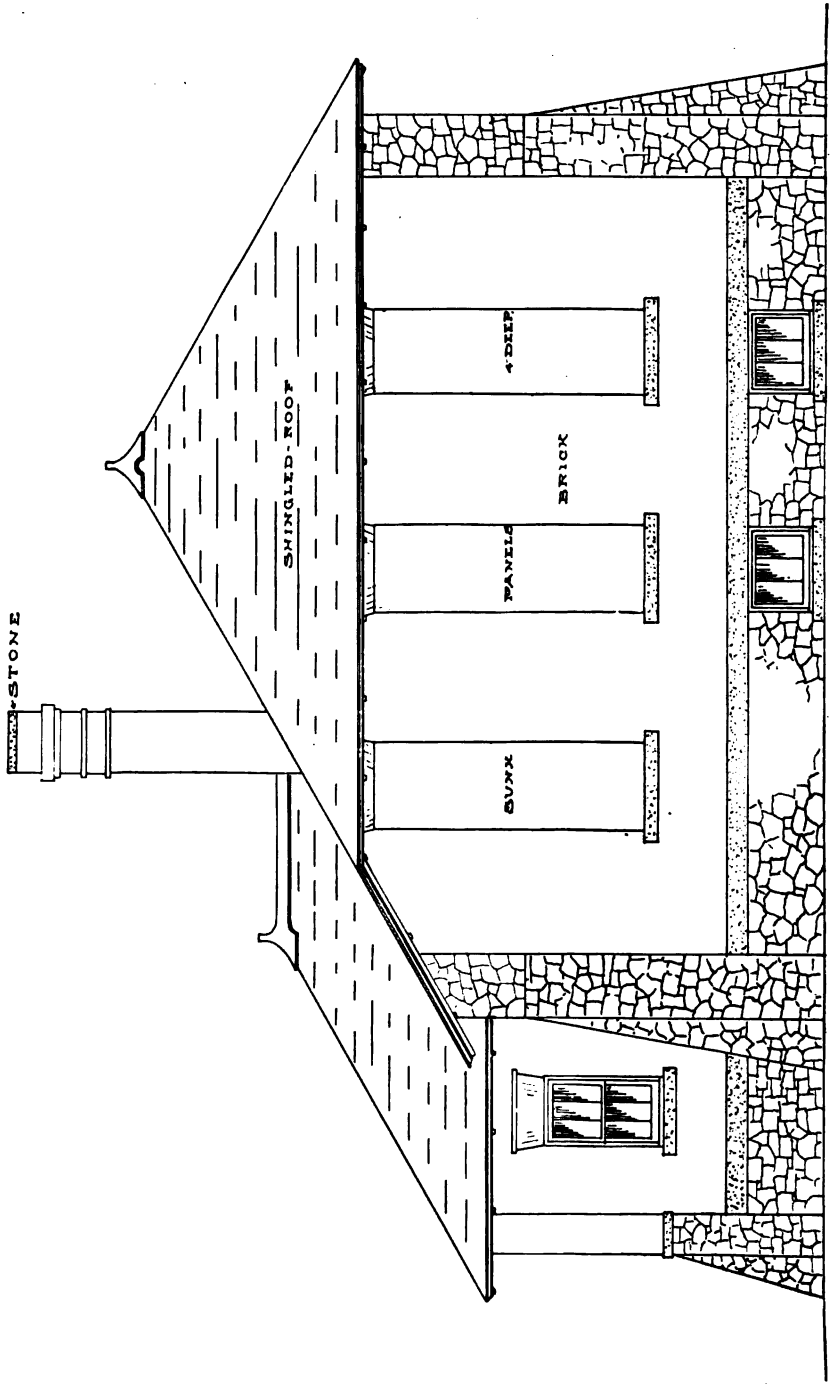


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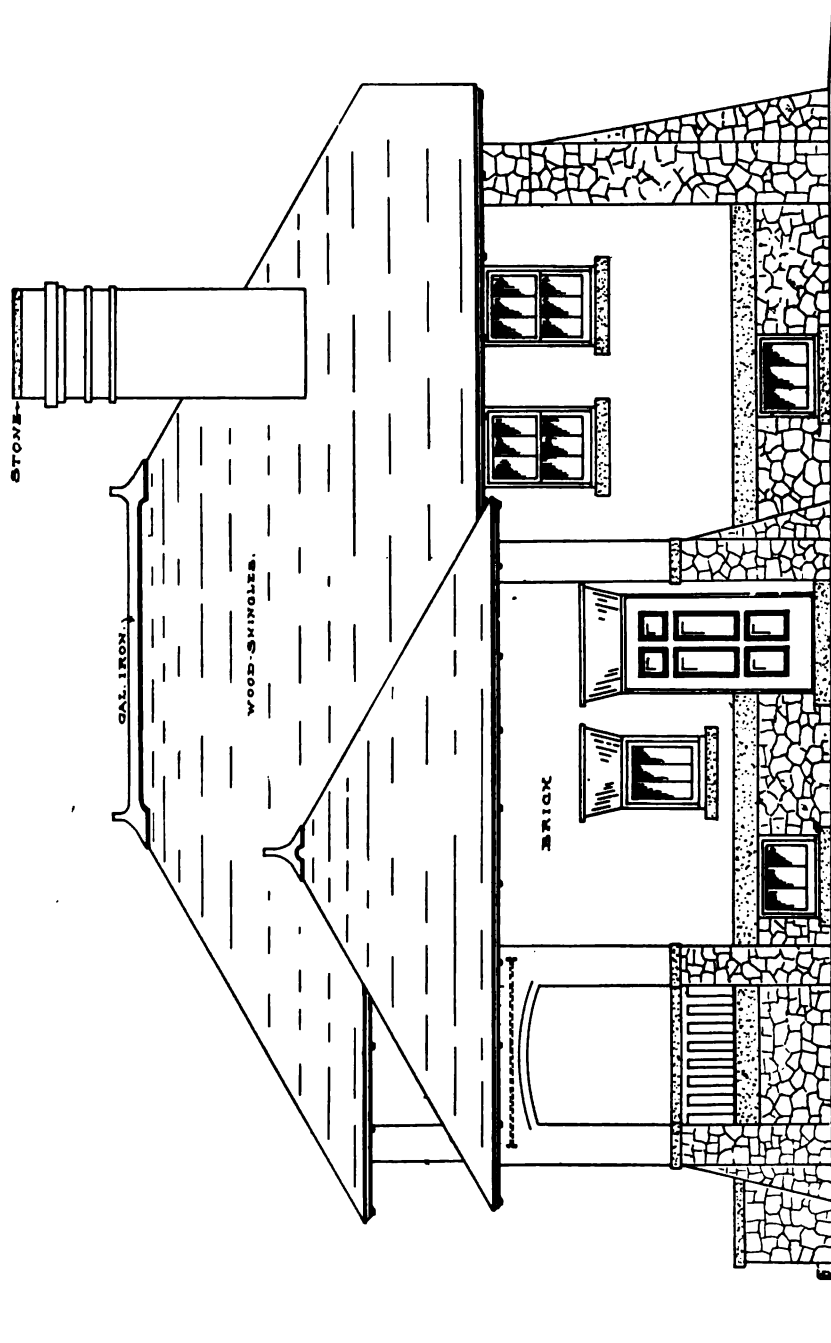




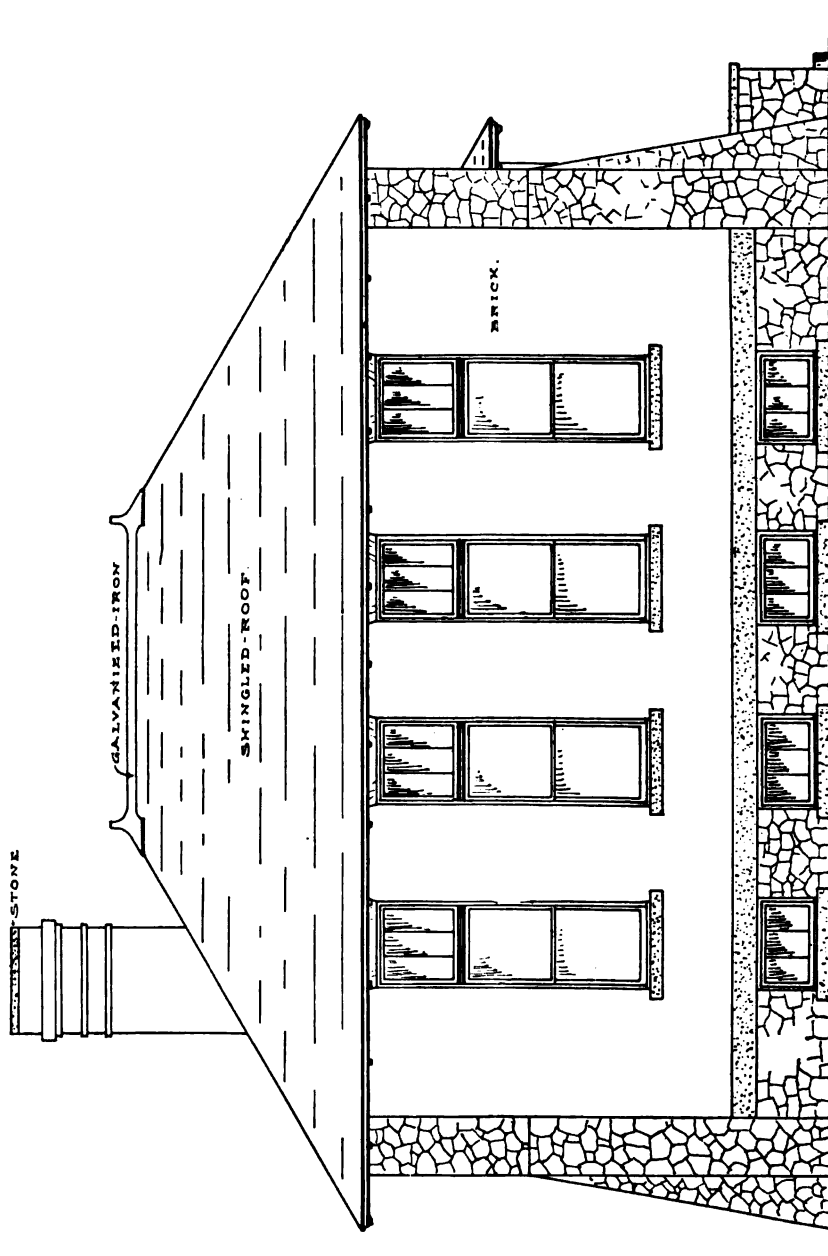
WISCONSIN STANDARD DESIGN A, FOR A ONE-ROOM SCHOOLHOUSE. KNAPP & WEST, ARCHITECTS. SEVEN SHEETS. SHEET 1.  
FRONT ELEVATION.



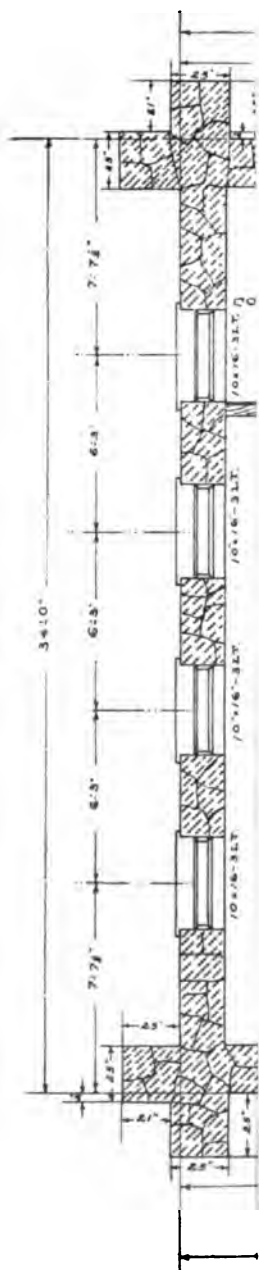
WISCONSIN STANDARD DESIGN A. SHEET 2. REAR ELEVATION.



WISCONSIN STANDARD DESIGN A. SHEET 3. SIDE ELEVATION.



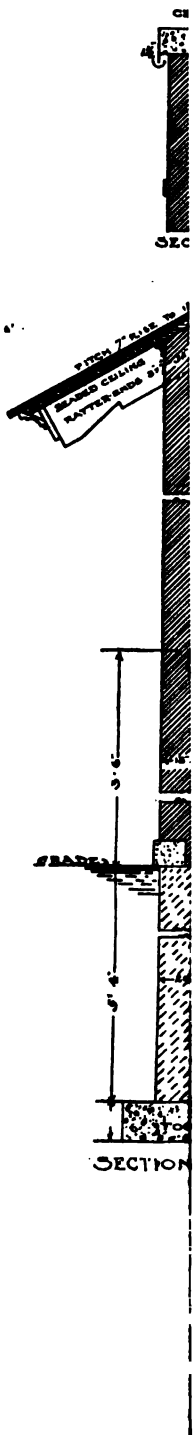
WISCONSIN STANDARD DESIGN A, SHEET 4, SIDE ELEVATION.



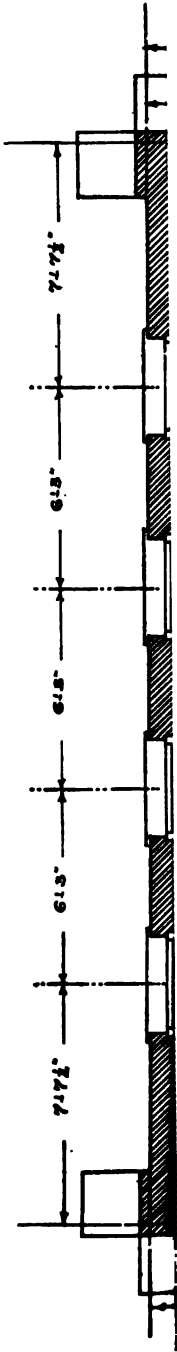




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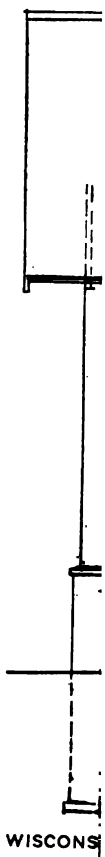








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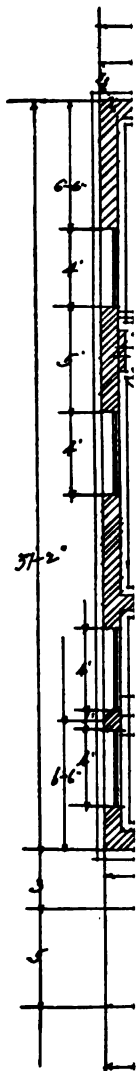


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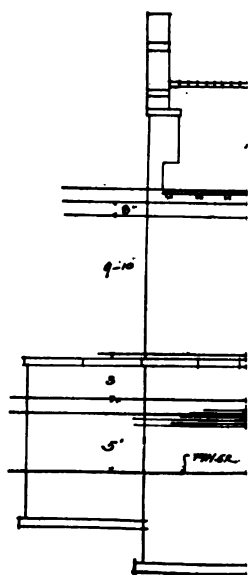
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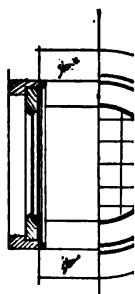


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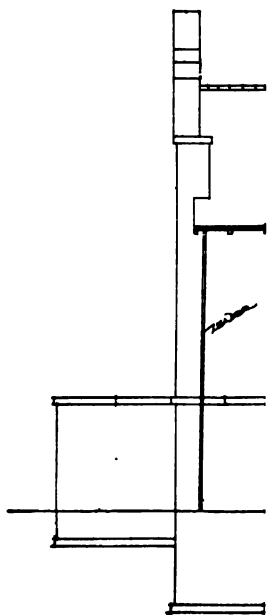
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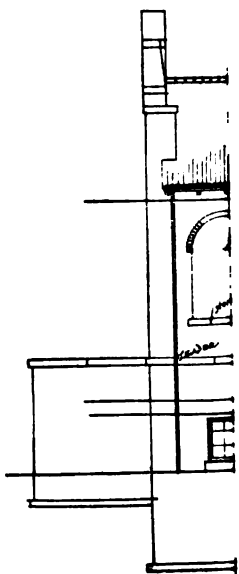
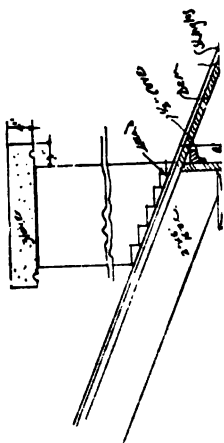


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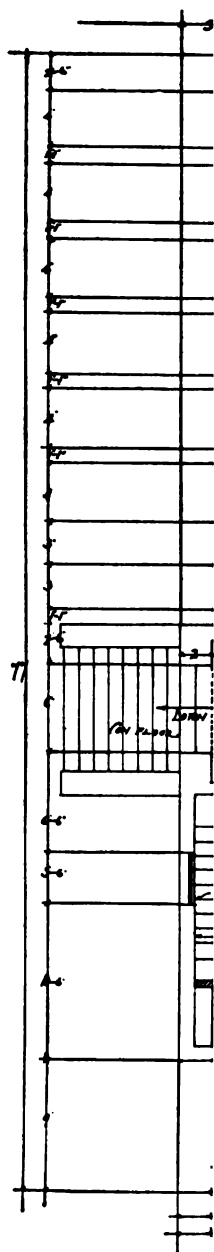


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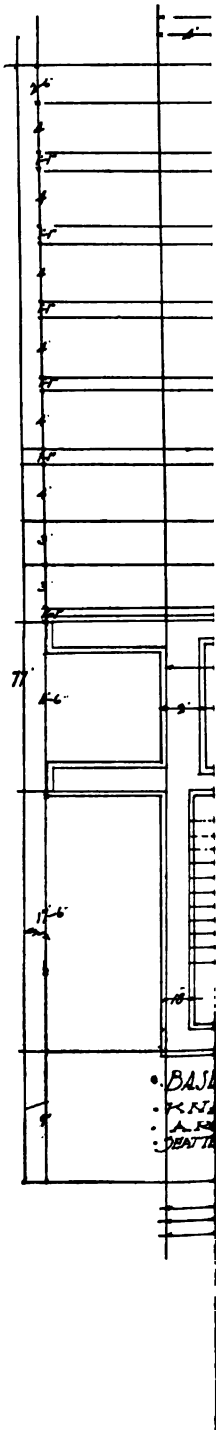


Report





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## APPENDIX A.

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## APPENDIX B.

### F. LOUIS SOLDAN HIGH SCHOOL, ST. LOUIS, MO.

The detailed description herewith given of this great high-school building was kindly furnished by Mr. Ittner, the architect, and it tells a new story in the history of education.\* Compare this with the best we had in our country 25 years ago, and you will understand the story better.

The plan presented is based upon the experience gained in the McKinley and Yeatman high schools, and after thorough consideration of the needs of such a building by the superintendent of instruction and the undersigned. The building proposed gives the necessary number of classrooms, laboratories, shops, etc., to accommodate normally 1,600 pupils.

#### LOCATION OF BUILDING.

As indicated on the photographic sketch plans submitted herewith, the building has been placed upon the central axis of the site, which fronts 390 feet on Union Boulevard by a depth of 306 feet on Fairmount avenue. It has been set 50 feet from the lot line on Union Boulevard, thus preserving the line established for the William Clark School and the Branch Library to the north.

The building is 288 feet in length by 256 feet in depth, leaving 51 feet to the north and south from the building to the lines of the lot on Kensington and Fairmount avenues. It is proposed to continue the north and south alley through to Kensington avenue, thus rendering the boiler room and shops more accessible.

The boiler room, coal room, all the boys' shops, and the generating plant are placed in a one-story wing to the rear of the main building, thus preventing the penetration of noise to the class rooms and laboratories.

#### ACCOMMODATIONS.

The building contains the following rooms:

##### CLASSROOMS.

Twenty-three class rooms, each 24 feet by 30 feet 6 inches, accommodating 48 pupils each.

Eighteen class rooms, each 21 feet by 25 feet, accommodating 35 pupils each. All of the above rooms are planned to be seated with desks.

##### SCIENCE ROOMS.

1. *Botany*.—Two laboratories, one 24 by 56 feet, and one 30 feet 6 inches by 39 feet; two demonstration rooms, one 22 by 24 feet, and one 22 by 30 feet; a conservatory; an instructor's room; and a storeroom; all of which are located along the south line of the building.

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\* For exterior views and floor plans see plates 50 to 55, inclusive.



2. *Physiology*.—Two laboratories, one 30 by 40 feet, and one 30 feet by 37 feet 2 inches; two demonstration rooms, one 22 by 24 feet, and one 21 feet by 25 feet 6 inches; an instructor's room; and a storeroom.

3. *Physics*.—Two laboratories, one 30 feet 6 inches by 34 feet, and one 30 by 40 feet; two demonstration rooms, one 22 by 24 feet, and one 22 by 30 feet; an instructor's room; and a dark room.

4. *Chemistry*.—Two laboratories, one 30 by 37 feet, and one 24 by 56 feet; two demonstration rooms, one 22 by 24 feet, and one 21 feet by 25 feet 6 inches; an instructor's room; and a storeroom.

5. *Physiography and commercial geography*.—One laboratory 30 by 40 feet; one demonstration room, 22 by 30 feet; and one apparatus and instructor's room.

The laboratories and demonstration rooms are all arranged to open en suite, so that the maximum use of the demonstration rooms may be obtained.

Each demonstration room is arranged for the use of a stereopticon and will accommodate 36 pupils in tablet arm seats.

Ample room for the storage of apparatus will be arranged in each instructor's room and in each laboratory.

#### SHOPS.

1. A woodworking room, 30 feet 6 inches by 65 feet; a wood turning room, 30 feet 6 inches by 80 feet; an instructor's room; a storage room for lumber; a finishing room; a tool room; a preparation and motor room; and a wash and locker room, all conveniently arranged with service entrance from the alley, all being located in the southern half of the one-story wing.

2. A machine shop, 30 by 60 feet; a forge room, 30 by 60 feet; a molding room, 25 by 38 feet; a generating room, 33 feet 6 inches by 30 feet 6 inches; a tool room; an instructor's room; a wash and locker room, occupying the corresponding portion of the rear wing to the north.

3. A domestic science room, 25 by 31 feet, with storeroom and dining room; three sewing rooms, each 24 by 28 feet, with two fitting rooms, all opening en suite; and a laundry, 24 by 25 feet, are located in the southern part of the basement of the main building.

#### DRAWING ROOMS.

Four art rooms, two 30 by 31 feet and two 30 by 38 feet, are provided on the third floor; each room is provided with north light through studio skylights. The rooms are arranged to open en suite, and are provided with a storeroom for supplies.

Three mechanical drawing rooms, two 30 by 31 feet and one 24 by 30 feet, each arranged with top light, are also provided on the third floor; a storeroom is also provided for supplies.

#### COMMERCIAL ROOMS.

Two commercial rooms, each 30 by 32 feet, with a supply and instructor's rooms and a banking office, are provided on the second floor.

#### OFFICES.

A principal's office, 13 by 24 feet; a reception room, 24 by 26 feet; and a business office, 24 by 40 feet, are provided on the first floor next to the main entrance.

The business office will be provided with a vault for school records.

A retiring room, 24 by 25 feet, with toilet, is also provided on this floor near the main entrance.

Each floor of the building above the basement is provided with a cloakroom for men and women of the faculty; each of these rooms will be provided with lockers and will open conveniently in the toilets on each floor.

#### AUDITORIUM.

The auditorium occupies the same location on the first floor as in the McKinley and Yeatman high schools; it has been enlarged to accommodate on the first floor 1,260 persons and in the balcony 432. It also has two boxes which will accommodate 29 persons each, making the total seating capacity 1,750.

The stage has been increased to 20 by 36 feet, and is arranged with dressing rooms conveniently located. It will be noted also that additional exits are provided for the auditorium connecting with the rear corridors, while emergency exits to the basement are provided on either side of the stage.

#### MUSIC AND LECTURE ROOM.

A music and lecture room, 36 by 54 feet, is provided on the third floor, and will accommodate 320 pupils.

#### LIBRARY.

The library, 34 by 36 feet, is located over the main entrance, with a separate stack room, 24 by 26 feet, conveniently located.

#### GYMNASIUMS.

In order to provide accommodation so that each pupil may spend not less than two periods each week in gymnasium work, two gymnasiums, each 30 feet wide and 80 feet long, with clear floor space, have been provided. The gymnasium on the boys' side is provided with a plunge bath, 14 by 20 feet, and four showers, as well as toilet and lockers; while the gymnasium on the girls' side is provided with the necessary lockers, toilets, and two showers. Running tracks may be arranged in each gymnasium if the same are required.

#### LUNCH ROOMS.

Two lunch rooms, each 40 by 80 feet, and providing accommodation for 900 pupils at a single lunch period, are located under the central courts, and are served from a common serving room and kitchen, located between the lunch rooms.

#### BOOK ROOMS, ETC.

Storage rooms for books, each 12 feet 6 inches by 21 feet, are provided on the second and third floors.

#### JANITORS' ROOMS.

A janitors' room, 21 by 24 feet, is provided in the basement, as well as a room on the second and third floors, each 12 feet 6 inches by 21 feet.

## STAIRWAYS, CORRIDORS, AND ENTRANCES.

The main entrance is located on the Union Boulevard front, with entrances to girls' locker rooms in the basement to the right and left.

Four entrances to the basement are provided, two for the boys on the north, or Fairmount Avenue front, and two for the girls on the south, or Kensington Avenue front.

A service entrance for the shops is located on the rear.

Four stairways are provided and are located at each angle of the building, thus minimizing the amount of travel. Two additional stairways are provided at either side of the stage and are serviceable for emergency exits from the auditorium.

The main corridor is 18 feet wide, the north, south, and east corridors are 10 feet wide. The corridors receive outside light for the greater part of their length.

On the upper floors the classrooms and corridor are carried over the auditorium.

## LOCKERS.

Ample accommodation is provided in the basement for individual lockers, there being two locker rooms for girls, each 21 by 83 feet, and one locker room for boys, 24 by 101 feet.

## HEATING AND VENTILATING.

The building is designed for a mechanical system of heating and ventilation, with a direct indirect system of heating for the boys' shops.

The boiler and coal rooms are placed to the rear of the auditorium on the alley, the air washer and tempering coils being placed in a room over the boilers.

The fans and engines will be located under the auditorium and isolated in such manner as will prevent the transmission of noise or vibration.

Special ventilation will be provided for the serving rooms and kitchen.

## DESIGN.

It is proposed to make the building harmonize in exterior design with the Wm. Clark School, using the early English style of the period of about 1620. The same brickwork and stone trimmings will be employed as in the Wm. Clark School. The central pavilion of the building, facing on Union Boulevard, will be carried somewhat above the general roof level, and the entrance and library bay above elaborated in a fitting way.

Should the preliminary sketch be approved, the plan will be elaborated and submitted to the board, together with the design, at a later meeting, for final approval.

## RECAPITULATION OF ACCOMMODATION.

	Rooms.
Classrooms (small) -----	18
Classrooms (large) -----	23
Art rooms -----	4
Mechanical-drawing rooms -----	3
Business rooms -----	2
Physiography and commercial geography -----	2
Library and stack room -----	2

	Rooms.
Physical laboratories .....	2
Chemical laboratories .....	2
Botany laboratories .....	2
Physiology laboratories .....	2
Demonstration rooms .....	7
Shops .....	5
Sewing and domestic science rooms .....	5
Gymnasiums .....	2
Lunch rooms .....	2
Locker rooms .....	3
Auditorium .....	1
Lecture room .....	1
Office rooms .....	3
Retiring room .....	1
New High School, total .....	92
McKinley High School .....	60
Yeatman High School .....	47

## COST.

Actual cubic contents, 3,382,000 cubic feet.

Cost, complete, \$629,000, or 18.5 cents per cubic foot.

The Wm. McKinley High School (including its addition) contains 2,493,000 cubic feet and cost 19.68 cents per cubic foot.

The Jas. E. Yeatman High School contains 2,260,000 cubic feet and cost 19.44 cents per cubic foot.

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### SUMNER HIGH SCHOOL, ST. LOUIS, MO.

The following detailed report to the board of education on the proposed plans for this building <sup>a</sup> was kindly furnished by Mr. Ittner, and is worthy of careful study. It is especially noteworthy in that the contract price was lower than his estimate. School boards often find the opposite true:

St. Louis, January 14, 1908.

*To the board of education of the city of St. Louis.*

GENTLEMEN: In accordance with the instructions of the board at its October meeting (see Pr. Pr., p. 151, Vol. XV), the undersigned presents herewith preliminary sketch plans for a new Sumner high-school building, to be erected on the lot purchased for the purpose on Cottage and Pendleton Avenues.

## LOCATION.

As indicated on the photographic sketch plans submitted herewith, the building is placed upon the central axis of the lot, which fronts 708 feet 3 inches on Cottage Avenue by a depth of 134 feet 6 inches to the alley. The building is placed next to the alley line, leaving 30 feet between the front of building and the lot line.

The building is 418 feet in length and 104 feet in depth. The boiler room, forge room, and molding room occupying the spaces under the open courts along

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<sup>a</sup> For exterior view see Plate 56.

the alley. The foreground along the front of the building is terraced and arranged for formal planting.

The playgrounds to the east and west of the building cover an area of 20,690 square feet each. It is proposed to pave them, leaving a planting strip along the street fronts.

#### ENTRANCES, STAIRWAYS, AND CORRIDORS.

Three entrances are provided to the building on the front, while three service entrances are provided to the shops, etc., from the alley.

Four well-lighted stairways are provided, located with a view of minimizing traffic between various parts of the building. Two are located convenient to the science rooms, classrooms, and shops, and two are placed near the center of the building, serving the central rooms and the auditorium.

#### ACCOMMODATION.

The building is built to accommodate 500 pupils and contains the following rooms: The classrooms, drawing-rooms, etc., are grouped in the central portion of the building, the science rooms, domestic-art rooms, shops, etc., being grouped in the east and west wings.

##### CLASSROOMS.

Eight classrooms, each 21 by 32 feet, and accommodating 48 pupils.

Four classrooms, each 21 by 28 feet, and accommodating 35 pupils.

All the above classrooms are on the first and second floors and have north frontage, are unilaterally lighted, and will be seated with desks.

##### SCIENCE ROOMS.

A botany laboratory 25 by 40 feet, with demonstration room 25 by 22 feet, apparatus room 11 by 17 feet, and a conservatory 11 by 19 feet are conveniently grouped in the south half of the east wing on the second floor. A physiology laboratory 25 by 40 feet, a physical and commercial geography laboratory 25 by 32 feet, and a storeroom complete the rooms in this wing on the second floor, the storeroom, 17 by 18 feet, and apparatus room being arranged for joint use.

A chemistry laboratory 25 by 40 feet, with demonstration room 25 by 28 feet, apparatus room 14 by 18 feet, and dark room 8 by 18 feet, and a physics laboratory 25 by 40 feet, with demonstration room 21 by 25 feet and apparatus room 11 by 18 feet, occupy the west wing on the second floor.

An instructor's room, 19 by 25 feet, is placed between the two laboratories arranged for the joint use by the instructors.

Each demonstration room is arranged with amphitheater seating 40 pupils, and may be used independently of the laboratories.

##### SHOPS.

A woodworking room 25 by 40 feet and a wood-turning room 25 by 40 feet are placed in the west wing on the first floor. These rooms are arranged with demonstration room 19 by 17 feet and a tool room 8 by 17 feet between for joint use, the demonstration room having an amphitheater. An instructor's room 19 by 18 feet, a preparation and store room 20 by 25 feet, and a washroom 14 by 18 feet are conveniently arranged for joint use by both shops.

A printing room 25 by 32 feet occupies the remainder of the space on the first floor of the west wing.

A machine shop 42 by 53 feet and an automobile machine room 42 by 53 feet, with garage 14 by 26 feet, occupy the ground floor of the west wing; a tool room 12 by 14 feet and instructor's room 13 by 14 feet are located between the rooms for joint use. The garage opens directly on the playground, with drive to Pendleton Avenue.

A forge room 32 by 46 feet and a molding room 32 by 30 feet occupy the space under the west court. These rooms are top lighted through ventilated skylights and have a store or supply room 14 by 21 feet. A washroom and toilet 16 by 22 feet for the shops is conveniently located.

#### DOMESTIC-ART ROOM.

A sewing and millinery room 25 by 40 feet, with two fitting rooms each 14 by 25 feet, a cooking room 25 by 34 feet, and a laundry 25 by 28 feet occupy the first floor of the east wing. The above rooms, together with the housekeeping suits, consisting of a model kitchen 14 by 16 feet, pantry 7 by 14 feet, dining-room 14 by 18 feet, and bedroom 13 by 14 feet, complete the rooms given over to domestic art.

#### DRAWING-ROOMS.

Four drawing-rooms are provided on the third floor, two for art, each 24 by 32 feet, with instructor's room 14 by 18 feet, and storeroom 11 by 18 feet, and two for mechanical drawing, each 24 by 32 feet, with instructor's room 14 by 18 feet, and store room 11 by 18 feet. These rooms will have north top light.

#### COMMERCIAL ROOM.

A commercial room 21 by 48 feet, with bank 15 by 16 feet, and instructor's room 15 by 16 feet, is provided on the second floor in the central part of the building.

#### ADMINISTRATION.

A principal's office 16 by 22 feet, with storage vault and toilet, a business office 15 by 31 feet, a reception room 15 by 31 feet, and an exhibition room 21 by 48 feet are conveniently located next the main entrance on the first floor.

#### LIBRARY.

A readingroom 31 by 48 feet, with stackroom 15 by 31 feet, with capacity for 10,000 volumes, and a mineralogical cabinet 15 by 31 feet occupy a central location on the second floor.

#### AUDITORIUM.

An auditorium 50 by 80 feet occupies the entire central portion of the building on the third floor. It will seat 750, has ample stage and dressingrooms, is well lighted, and is accessible from the four stairways.

#### GYMNASIUM.

The room spaces over the laboratory and shop wings have been utilized for boys' and girls' gymnasiums. The rooms are each 30 by 78 feet, with a clear-story height of 15 feet. Each room is well lighted and is provided with a shower, locker, and toilet room of adequate size. A swimming pool 20 by 20 feet is provided on the ground floor next the boys' locker room.

## LUNCHROOM, ETC.

A lunchroom 53 by 71 feet occupies the ground floor of the east wing. The room will accommodate 350 pupils at one lunch period, has a serving counter across one end, and the necessary kitchen, storeroom, help's toilet, and service entrance to alley.

## LOCKER ROOMS.

Accommodation is provided on the boys' side for 200 lockers and on the girls' side for 400 lockers. They are placed in well lighted and ventilated rooms close to the entrances and stairways.

## TOILETS AND TEACHERS' ROOM.

Two teachers' rooms are provided on each floor for the men and women of the teaching corps. The rooms are located near the general toilets, and each is provided with lockers.

Two retiring or rest rooms are provided on the first floor convenient to the shop wings.

The general toilets are arranged in stacks and are located on each floor, the adequate number of fixtures being installed in each.

## HEATING AND VENTILATING.

The building is designed for a mechanical system of heating and ventilation, with direct radiation in the shops.

The boiler and fuel rooms are placed outside of the main walls of the building under the east court.

The fans will be placed in the central part of the building on the ground floor.

The system is designed for eight air changes per hour in all class rooms, laboratories, etc., and four changes in the corridors, shops, etc.

## RECAPITULATION OF THE ACCOMMODATION.

Large class rooms.....	8
Small class rooms.....	4
Mechanical drawing rooms.....	2
Art rooms.....	2
Laboratories .....	5
Demonstration rooms .....	4
Commercial rooms .....	1
Shops .....	6
Printing .....	1
Domestic art .....	3
Housekeeping .....	4
Library and stack room.....	2
Office and reception rooms.....	3
Gymnasium .....	2
Lunch room .....	1
Locker room .....	2
Auditorium .....	1
Retiring rooms .....	2
Teachers' rooms.....	4
Total number of rooms.....	57

## COST.

The building contains 1,999,680 cubic feet.

Contract for complete building was \$297,823, or 14.9 cents per cubic foot.

## RECOMMENDATION.

It is recommended that the sketch plan be approved and the undersigned authorized to perfect the same and submit the plans to the board for final action.

Respectfully submitted.

WM. B. ITTNER,

*Commissioner of School Buildings.*

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PROPOSED HIGH SCHOOL, COLUMBIA, MO.

I am under special obligations to Mr. Wm. B. Ittner, the architect, for the floor plans (see pls. 14, 15, and 16) of the proposed high-school building for Columbia, Mo., and the detailed description of it. There are some special features proposed which deserve notice, viz, the location of the gymnasium and its lighting, the study hall, the distribution of the toilets and baths, etc.

## FIRST FLOOR.

The first floor contains the following:

*Auditorium.*—seating 505 persons on the first floor and 280 persons in the gallery, a total of 785 persons. It occupies the front central portion of the building and is amply lighted and well provided with exits.

*Manual training.*—For manual training there is a woodworking and wood-turning room 21 by 54 feet, accommodating 18 pupils in woodworking and 12 in wood turning. The room is provided with a lumber-storage and finishing room. There is also a mechanical-drawing room accommodating 18 pupils. All of the above rooms are conveniently arranged for supervision by a single instructor, if need be.

*Domestic art.*—For domestic art, a sewing room 21 by 36 feet, with a large fitting and store room, and a cooking room 21 by 36 feet, with a large storeroom, are provided. Each of the above rooms will accommodate 24 pupils.

*Locker rooms.*—Provision is made for 200 lockers for boys and 400 lockers for girls. The rooms are conveniently located with respect to the corridors and exits.

*Entrances.*—Four entrances are provided, two to the North Eighth street front and two to the playground.

*Toilet rooms.*—There are two toilet rooms on each floor, one for boys and one for girls. The rooms are arranged in stacks, and will contain the proper number of fixtures.

*Stairways.*—Two stairways are provided; they are located at the center of each wing, thus minimizing the travel distance between the various rooms of the building, and are well lighted.

*Corridors.*—The corridors are direct, well lighted, and of the minimum width to accommodate the school.

*Gymnasium.*—A gymnasium, 38 by 75 feet, is placed in the court between the wings. This room will have a clear height of about 19 feet, is provided with locker and shower rooms for both sexes, has convenient exits to playgrounds, and has an instructor's room connecting therewith.



## SECOND FLOOR.

Besides the auditorium balcony, the second floor will contain the following: Two classrooms, each 18 feet by 25 feet 6 inches, accommodating 25 pupils; two classrooms, each 22 by 22 feet, accommodating 25 pupils; and six classrooms, each 21 by 24 feet, accommodating 30 pupils; a total of ten classrooms, all of which are unilaterally lighted, and of the proper size to accommodate the number of pupils given.

## THIRD FLOOR.

The principal feature of the third floor is a large study hall. It is placed over the auditorium, and will accommodate 250 pupils in single seats. The ceiling of the room will be raised somewhat above the general third-story level, will be beamed and have skylight with diffusing sash, giving uniform light throughout the room.

Adjoining the study room on one side is a reference library and on the opposite side an office. The screen dividing these rooms from the study hall will be glazed, thus permitting the teacher in charge of the study room to supervise the office and library.

The above rooms will be top lighted and admirably suited for their purpose.

Next to the office an ample store room for school supplies is provided.

*Laboratories.*—A biological laboratory 21 by 36 feet, accommodating 20 pupils, and a physics laboratory 21 by 36 feet, accommodating 18 or 20 pupils, have been arranged in the south wing. These rooms open on to a lecture room 21 by 22 feet, with amphitheater which will accommodate very comfortably 60 pupils. An instructor's room and apparatus room is conveniently located to the physics laboratory.

Besides the above, there are six class rooms on this floor, two class rooms 18 feet by 25 feet 6 inches, accommodating 25 pupils each; one class room 22 by 22 feet, accommodating 25 pupils, and three class rooms 21 by 24 feet, accommodating 30 pupils. All of these class rooms, like the class rooms on the floor below, are unilaterally lighted and of ample size to accommodate the number of pupils given.

## EXTERIOR.

The exterior of the building has been treated in collegiate English of the Tudor period, the exterior walls being faced with a mixed vitrified brick on a stone underpinning, while the central portion of the front and the towers will be trimmed with cut stone and the roof will be covered with slate.

## COST.

The building as planned contains about 789,000 cubic feet and can be erected ready for its equipment for about \$125,000.

## RECAPITULATION OF ACCOMMODATION.

	Pupils.
Auditorium .....	725
Study hall .....	250
Manual training:	
Woodworking .....	18
Wood turning .....	12
Mechanical drawing .....	18

Domestic art:	Pupils.
Cooking -----	24
Sewing -----	24
	48
Science rooms:	
Biology -----	20
Physics -----	20
Lecture -----	20 to 60
	60
Class rooms:	
Seven rooms, at 25 -----	175
Nine rooms, at 30 -----	270
	445
Gymnasium, can be equipped for classes of -----	50
Locker room, office, library, toilets, rooms for heating plant and fuel.	

### POLYTECHNIC ELEMENTARY SCHOOL, PASADENA, CAL.

The following description of the Polytechnic Elementary School at Pasadena\* was written by Mr. Hunt, the architect, and reprinted from *School Architecture in California* by State Superintendent Edward Hyatt:

There is little that can be said about the scheme that is not obvious on the face of the plan. It is well adapted to the warm climate of California. Its picturesqueness and the flexibility of the parts, making it possible to add to the school as it grows, seem to be features that might be of interest to school boards having a similar problem.

This plan ought to be usable in many parts of California where a school of moderate size starts under conditions that indicate a possible future growth. You can easily see that the advantage of having sunlight in all rooms and having the entire building on the first floor is worth considering. The actual working out of the system in the school for the past two years has been a great success. When we have some money we just add another room. The broad, covered porches make a place for the children to play in rainy weather; stuffy corridors are eliminated. We are having no trouble at all in heating the building, using a system of forced air. The whole thing as it stands cost less than \$25,000. We figure that it cost about \$1,000 per room, everything included, and no doubt could be done for less if it were simplified.

The building is in every way adapted to ideal school conditions in this climate. It is of one story in the so-called California style. A unique feature of the arrangement is the extension of the broad, cement-floored colonnade which surrounds the front or north patio entirely through the building as a sort of hall and around two sides of the patio on the south. This leaves the assembly room, which is in the center of the building, surrounded on three sides by roofed out-of-door passageways, upon which the class-rooms open.

These broad open-air passageways hum with the life of the children. They play there whenever they wish, and thus the colonnade is the scene of much of the social life of the school.

\* For view of exterior and of assembly room, see Plate 85.

The lines of the building are broad and simple. The interior is finished in Oregon pine, and various tones of brown provide the color scheme.

A large brick fireplace is one of the beautiful features of the assembly room, and a cheerful wood fire is kindled there on dark days.

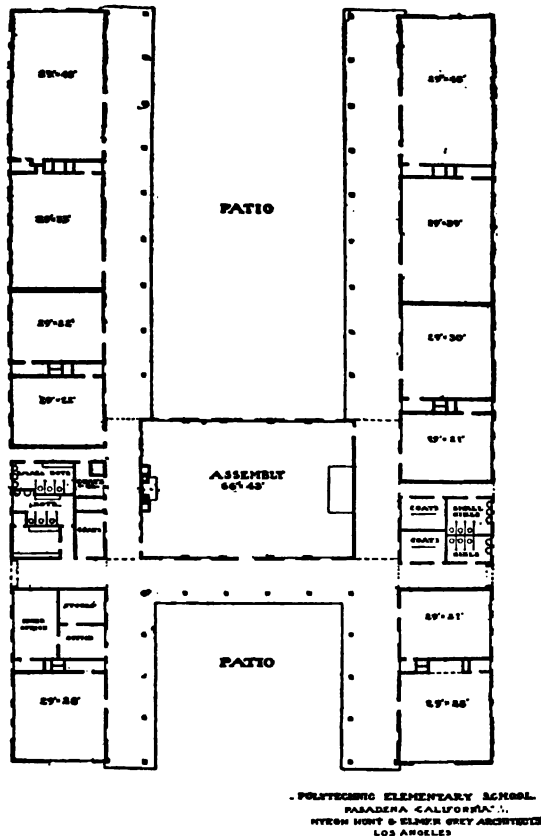


FIG. 12.—Polytechnic Elementary School, Pasadena, Cal., floor plan.

The building contains ten classrooms in addition to the assembly room, offices, dressing rooms, janitor's room, and storerooms.

The rooms are planned to admit as much light and fresh air as possible. The windows, of which there are an unusual number, are broad, and the sunlight penetrates to every corner of the building.

Special attention is paid to the heating and ventilation of the rooms. The whole building is heated by hot air furnaces with a forced draft.

## APPENDIX C.

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### TYPES OF MODERN SCHOOLHOUSES.

I have not attempted in any way in the following classification to discuss in a technical fashion the various styles of architecture revealed in the school buildings of our country. So far as I can see, the buildings are for the most part like the American people, a complex of types from nearly all lands, and defy specific classification.

I trust that it will also be noted that many buildings combine features of several of the types indicated, and could be classified in either of the groups. Some are altogether excellent, most of them are good. Taken together they represent a sort of cross section of present-day conditions in our country as a whole. They are presented not only for individual study, but as educational and sociological data through which we may look into the faith of the people and thereby understand their motives with reference to the present and future needs of their children. School buildings are the most significant buildings of this age, especially to those who have power to understand the true mission of public education.

*The passing of the belfry.*—School buildings without towers or belfries are becoming increasingly common. It gives one a good deal of relief to see that we are slowly getting rid of those useless, impertinent, and expensive towers, which have for such a long time weighted down many of our school buildings, shocked all artistic natures, and wasted the public money. They are remnants of the time when schools and churches were organically connected, and they remain with us as a reminder of that fact. Generally they are unsightly, dangerous in time of storms or earthquakes, and expensive beyond all possible need. In country districts and villages this tower has been continued as a belfry, but there is now little need of a schoolmaster regulating the time of a town, and a hand bell or a bugle will serve all other purposes for which a large bell is now used; but even if a large bell is demanded for merely sentimental reasons it can be placed in some inconspicuous place rather than in an expensive tower, which is usually wholly out of harmony with the rest of the building. There are a few architects in our country who occasionally use towers on their school buildings and make them so completely harmonious that they seem in keeping with the structure and are apparently needed, but the day of the tower on school buildings is in its twilight. It is certain that school bells are going out of fashion, and much relief will come when they are forever gone. As suggested, there is a tinge of sentiment attached to these bells, especially as one recalls his bygone college days, but it is far more rational and would be more pleasing to the young people of to-day to put the cost of towers and bells into a piano or a pipe organ for the assembly room.

A few buildings with towers are illustrated in the plates which follow, not to show the style of architecture which includes that form of decoration, but on

account of some special excellence in the design of those buildings in other respects.

*Appropriate ornamentation.*—We are beginning to emerge from a period when architects felt it their duty to ornament the exterior, but to give little thought to the interior. Along with inappropriate towers went curiously shaped and badly placed windows, all put in for their supposed architectural effect rather than for the purpose of properly lighting the interior. I know of one building where, as a result of this demand for outward show, the windows are actually cut into two parts by the floor of the second story, and of course neither the first nor second floor was lighted in any satisfactory way. Elaborate cornices and "gingerbread stuff" are still in evidence, but they are disappearing, and beauty of proportion and fitness for use, the keynotes of architecture, are coming to demand more thought and even to command respect from school trustees.

It is too much to claim that all the houses included in the illustrations in this book are free from excessive decoration, but they do without question indicate the prevalence of better taste and judgment.

*Unilateral lighting.*—Another type has appeared and is characterized by unilateral lighting for all classrooms. This type has been developed because of the necessity of an increased amount of reading and writing and to meet the demands of teachers and oculists who have discovered that many of our school children are suffering from defective eyesight due to badly lighted rooms. Those who have had a hand in the inauguration of this change have had to meet the objections and opposition of a large percentage of those architects who had been accustomed to planning the old form of building. This type has indeed introduced many difficulties for architects to overcome, but happily they are now realizing that schoolhouses are for the purpose of properly caring for the minds and bodies of children during their education, rather than opportunities for exploiting fancy architectural features. Blank walls must now be handled skillfully, and even harmony and balance must be sought in a new way, in order to introduce sufficient light from the proper source and in the right way. The fight for this form of building has been waged by the schoolmen and health officers against the prejudices of the people, and to some extent against the self-interest of architects. The examples of this type here given will, I think, more than commend themselves to those schoolmen who think first of the health and care of the pupils and next of the appearance of the schoolhouse. And here, to prevent any misunderstanding, let me say again beauty in school architecture is a matter of great importance. Some day it is to be hoped that only our sane artist architects will be allowed to spend our public money on school buildings, for they ought to stand as models of taste and good form to the whole community in which they are erected. But it can not be denied that health, convenience, and safety ought to come first, even if historically they were the last considerations to emerge.

Beautiful halls, large and well-appointed assembly rooms, attractive staircases, mural paintings, well-proportioned classrooms, a few well-chosen art models, and tasteful furniture are more educational than fancy stucco or all the imitation friezes and cornices often lavishly supplied. Germany is certainly leading the world in the interior decoration of their newer school buildings because they employ their best artists to do such work.

Buildings are numerous in which the ideas advocated in this section are illustrated, but especial reference is made to Plates 178, 179B to 182, 194 to 196, and 215, showing buildings in Cleveland, Ohio, Seattle, Wash., and Springfield, Minn.

*Flat roofs.*—There is in process of development a form of school building, numerously illustrated in this work, that might with propriety be designated a

distinctly new type. I refer to that form using a "flat" roof. This has been developed to meet the desirability of relieving large buildings of a heavy and expensive roof, which increases fire risk and demands for support heavy walls thoroughly tied together. In this method of roofing school buildings the architects have followed the development of business houses. In several cities, notably New York, under the able guidance of Mr. Snyder, these flat roofs have been turned to a novel but a very worthy use, aside from protection from the elements. Roof playgrounds have become an important factor in the educational life of New York. The photograph reproduced in Plate 216 represents a gymnastic exercise in progress on the roof of one school, and is truly a type of something new in schoolhouse construction.

*"Mission" architecture.*—There is, from the strictly architectural point of view, another type or style in process of development in the West, and especially on the Pacific slope. This is the so-called mission style. This form first found expression in mission churches and in smaller school buildings, but is now occasionally seen in larger buildings. It lends itself especially to one-story buildings, and preferably to those built about a court. The examples given in plates 188 to 193, 237, and 238 will represent the characteristic features of this style, and will, I think, commend themselves on account of their simplicity and beauty.

The feeling dominant in this style of architecture harmonizes in a peculiarly artistic manner with the sunshine and brown tints so characteristic of the Southwestern States. Even in the moister climates of the Southern States where the gray greens are so characteristic it blends with the environment in a very pleasing way. It is a matter for congratulation that our people have seen the possibilities of this style and that an increasing number of architects are utilizing it. But it ought to be suggested that it is altogether questionable to construct frame shells and stucco them in a sort of make-believe fashion. Thick solid walls of strong solid concrete, or plain concrete blocks, softened with clinging vines give a very pleasing effect. The roofing material for this style should always be red earthen tiles. Nothing else is so effective.

*The "H" plan.*—The type of building known as the "H" plan if I mistake not was first used by Mr. Snyder, of New York City. He found it necessary on account of the limited space at his command, and because the blocks in that city are longer from east to west than from north to south, to face the long sides of his buildings to the north and south. This caused trouble with the light. But by using the "H" plan a great majority of classrooms are made to get either east or west light. This type has proved itself so useful that modified forms of it have been introduced in many other cities. Examples of this form of construction may be seen in plates 1, 154 to 156, and 167 to 170.

*Provision for enlargement.*—Buildings designed for future additions have been hard to plan in order to make them acceptable before final completion. The particularly rapid development of the city of Seattle, Wash., has brought about the adoption of a standard plan of schoolhouses devised with special reference to future enlargement. All the grade buildings of the city are now constructed upon that plan, the final result being a house of the H form. The middle bar of the H, containing nine rooms, is built first, and the wings, each of eight rooms, are added as they are required. Plates 194 (A and B) and 195 A show the three stages of development.

The exteriors are modified for the sake of variety, but the standard plan is followed in all. The Adams building, shown in Plate 195 B, is now in the second stage, with 17 rooms; the view shown is that of the right wing. Plate 196 (A and B) illustrates two other buildings in the first stage.

In Cleveland, Ohio, the method of constructing half the building at a time is in use. Plate 178 shows examples of this, the dividing line of the units being at the flagstaff on the Rice building and at the two narrow windows in the front of the Halle building. The same general idea is carried out in the plan of the Herbert Spencer School in Chicago (pl. 162), that being half its contemplated final size. A common method of extension is shown in Plate 179 A, which is, in effect, merely a new building connected with the old one by a covered passageway. Still other methods of building with reference to future additions are shown in the Langston building, in Washington (Pls. 197-199), and the new building at Melrose Park, Ill. (pls. 200 and 201).

*Rural schoolhouses.*—The type of country school building which has been prevalent in our country for a century is one of the most forlorn and desolate structures one can imagine for such a purpose. There has rarely been any thought whatever of real beauty, and in the main it has been the product of "hatchet-and-saw" carpenters, with no plans to guide and no ability to read them even if they had been furnished. Usually, the three dimensions were given, and nothing else in the way of guidance seemed necessary. The result is that not one in a thousand has attained any approximation to good lines. The roof had no relation to the structure as a whole, save that it was devised to keep out the rain. Windows are inserted at random, and doorways are mere holes in a wall.

It is therefore a genuine pleasure to those who are solicitous about the matter of the growth of taste in our country to see the beginnings of a real and well-directed movement in favor of better and more artistic country schoolhouses. For the progress of this movement we are in a large measure indebted to the good women of our land who have organized school-improvement associations and are grappling bravely with the problems of rural school architecture, better school gardens, larger playgrounds, better sanitary arrangements, and everything that looks toward a more wholesome environment for country school children. The examples of country school buildings here given are, on the one hand, the remnants of a type which I hope is rapidly passing away, while the examples of the newer type are, I trust, only a promise of a still higher ideal to be attained in the near future.

Detailed plans for one, two, three, and four room buildings were kindly furnished by State Superintendent C. P. Cary, of Wisconsin (pls. 243 to 267). They were made under his direction to guide in securing modern conveniences and good sanitation for the country and village districts of his own State, but they are deserving of a wider consideration. Many other state superintendents have prepared plans for school buildings and they all deserve much credit for the interest they have shown in urging the construction of better buildings and demanding better hygienic conditions.

Superintendent Hyatt, of California, has recently issued a special bulletin on schoolhouses and school sanitation in general. It is vigorous and very helpful.

*German school buildings.*—Germany is now in the midst of a decided development in school architecture, and the types emerging are most interesting in comparison with those we have developed in our country.

(a) In the first place, their buildings are generally taller than ours, are narrower, and very frequently are built on a corner in an "L" form. This form gives them a half court for garden and playroom, and the halls open either from this court or from the street side. But this form gives north or south light in about half the building. This is not so serious with them as with us, because of their latitude and a more equable climate.

(b) They provide, in connection with their secondary schools, a house for the principal or director. This they are able to do because there is less moving about among their teachers and because more men enter the profession to make it a lifelong business. I believe it would mark an advanced step in our professional progress to begin a movement in our country that would look toward some provision for supplying a home and a garden for our principals, thereby furnishing an inducement to lengthen the professional career of our best men teachers, and possibly to attract stronger men to the work of public education. The Germans make little provision for playgrounds, but always have a gymnasium in which regular physical training under a competent teacher is given. In addition a "festsaal or aula" they regard as a necessity and strive to make it attractive as a center for music, lectures, and festival occasions of all kinds. In contrast with our plan, they generally locate this assembly room on the top floor, and do not generally incline the floor or make provision for a gallery. In these two particulars our usage is to be preferred.

(c) There is a well-marked movement noticeable to make their school buildings more homelike in their appearance than is observable here. As a result the newer buildings show a form of roofing quite different from our flat-roofed type. Their buildings are of stone or brick, and generally show more external and internal decoration than is often found in the same class of buildings in our country. They utilize their best artists for such work, and take great pride in the art thus displayed.

*Special types.*—The beginnings of a movement to construct a type of school buildings designed especially to meet the needs of defectives and delinquents are in sight. Naturally, this movement originated in the large cities, and has made as yet little progress. But the idea suggested by the types here reproduced is a worthy one and will in time operate to the advantage of children heretofore poorly accommodated in the ordinary schools. (Pls. 218 to 228.)





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